which is another reason why these modifications needed to occur. Whenever the new applications are created, the hope is to ensure that all necessary information is available for all systems.

DHS Analyst Software Implimentation. *Christopher Whitehouse* (*Big Bend Community College, Moses Lake, WA*); *Mary Sue Hoxie* (*Pacific Northwest National Laboratory, Richland, WA*). The objective is to see how analytical programs such as Collaborative Analytical Tool (CAT), ProSPECT, IN-SPIRE, and Analyst Notebook (ANB) will help in analyzing investigative data. Before any of the tools could be used we needed to convert the data into a usable format, plain text. My lab partner, Sherwin Hunte, created a program to automate extraction of a PDF (portable document format) file into separate smaller PDF files. After converting all the documents we imported the data into the separate programs. I used CAT to index all of the files related to the data. These files included Excel, Access, Adobe Acrobat, and text documents. CAT is very useful because it can index several different file types and group them into different data sets. I also imported the data into the ANB program and created timelines for the data. This was a very useful tool except after importing the data it requires a lot of the organizing of the timeline by hand. These analytical programs simplify looking at data that is convoluted. They allow us to visually search through and cross reference the data. These programs also make it a lot easier to find specific information and reference it as needed to support or refute Hypotheses, which allows for stronger hypotheses and better understanding of the data being analyzed. Though the way the data is gathered may need revising, I do think these tools would be helpful to any analyst working with convoluted or disjoined data.

A Case Study of the Performance of Speculative Asynchronous Simulation on Parallel Computers. *Patrick Wilkerson* (*Austin Peay State University, Clarksville, TN*); *Kalyan Perumalla* (*Oak Ridge National Laboratory, Oak Ridge, TN*). Modern supercomputers use thousands of processors running in parallel to achieve their high computational speeds. However, on such large processor counts, communication and synchronization operations can waste valuable processor time. Communication involves processors exchanging intermediate computed data that needs to be shared by processors at runtime. Synchronization involves processors ensuring the mutual orderings of operations across processors are correct. In this work, we investigated the runtime efficiency of two methods that are aimed at reducing communication and synchronization costs, respectively, namely, asynchronous updates and speculative execution. The experimental investigation is performed on a parallel finite difference time domain (FDTD) simulation developed at ORNL, which has wide applicability in simulating various physical system phenomena. It uses an iterative algorithm to reduce communication by allowing messages to be asynchronously sent when the change in values on a given processor is greater than some threshold value. We conducted research to develop an empirical performance study of the algorithm. The first part of asynchronous updates is accomplished by exploring the effect of threshold-based communication on overall runtime of the parallel simulation, with the number of processors increasing. A significant improvement in performance on up to 64 processors was observed when using the asynchronous update scheme, due to reduced communication. We are currently working on the synchronization aspect of the problem, to relieve the tight coupling among processors, using “speculative execution” with sophisticated “rollback” techniques being developed in an ORNL Laboratory Directed Research and Development (LDRD) project. In speculative execution, processors are allowed to progress without having to wait for other processors, but any violations in ordering of computations are detected and corrected using rollback techniques. Further research is being done to implement a rollback mechanism necessary for optimized parallel execution. Preliminary results on a special case of the synchronization mechanism show improved speedup over and above the gains of asynchronous updates on up to 64 processors. We are working towards implementing the more general rollback method and expect to complete the performance study on the generalized asynchronous speculative execution.

Vascular Smooth Muscle Cell Migration Modeling. *Matthew Woerner* (*Tufts University, Medford, MA*); *Jim Nutaro* (*Oak Ridge National Laboratory, Oak Ridge, TN*). The migration of vascular smooth muscle cells is a catalyst for intimal hyperplasia, the thickening of the arterial walls in response to an injury in the blood vessel. Cell migration can be quantified using Boyden Chamber experiments. A model by Jabbarzadeh and Abrams model is used in designing this model. While this model is based on Jabbarzadeh and Abram’s model, our model contains several differences. In this algorithm, eukaryotic cells were modeled, instead of bacterial prokaryotic cells in their model, which slightly changed the nature of how cells move. A hybrid model, a model containing both discrete and continuous parts, was developed to simulate Boyden Chamber experiments in order to better understand cell migration. The hybrid nature of this model accounts for motion of individual cells, diffusion of the chemoattractant, and the interaction between the chemoattractant and cells. This model is being built using a C++ code and a discrete event system specification (DEVS). In the future this model will provide the foundation to aid in predicting the appearance of intimal hyperplasia following balloon angioplasty.

Two Case Studies of Reversibility in Computational Methods. *John Wright* (*Mercer University, Macon, GA*); *Kalyan S. Perumalla* (*Oak Ridge National Laboratory, Oak Ridge, TN*). Currently state-saving is employed in many large simulations to realize rollback. Reverse computation is a recently proposed method which computes previous states instead of saving them. This approach can be beneficial on large machines as computing power is abundantly available and is possibly more efficient than retrieval from memory. This project investigates the reversibility of the well known Newton-Raphson root finding method and the possibility of developing a reversible interface for the Level 1 (vector) operations found in the Basic Linear Algebra Subprograms (BLAS) library. The mechanics of Newton-Raphson were studied and an algorithm was developed to reverse each iteration in the forward method. The reverse method involves finding the root of a derived function and forward Newton-Raphson is used on the derived function. Consequently, reverse Newton-Raphson gains the strengths and weaknesses found in Newton-Raphson. The reverse method has produced favorable results on functions that converge with forward Newton-Raphson. Unfortunately the forward method behaves unpredictably when multiple roots, periodic behavior, local minima, etc. exist in the target function and the reverse method will also produce unpredictable behavior in these cases. Further research is needed to handle unpredictability in certain functions in the reverse method. Routines in the BLAS Level 1 were analyzed and candidates were chosen based on the need for reversibility. Only those routines which modify input values require reversal. Reverse routines were developed for Givens rotation, vector scale, vector swap, and vector scale and update (saxpy). The reverse routines have shown identical scaling to their forward counterparts, however some problems concerning precision need to be resolved. Further work is needed to improve the interface to realize transparent reversibility for the vector copy operation. The forward BLAS library will need to be modified to implement copy reversibility.

Extending the MPI-Serial Library to Support Derived Datatypes. *John Yackovich* (*Shippensburg University of Pennsylvania, Shippensburg, PA*); *Robert Jacob* (*Argonne National Laboratory, Argonne, IL*). The Message-Passing Interface (MPI) standard is widely used to manage communication between networks of processors working on a single problem. MPI defines a set of derived data type constructors for the C and Fortran languages to enable the communication of multiple pieces of information simultaneously between processors, thus minimizing both the overhead of these communications and the effort required by the user. There is a compatibility library implementation of the MPI standard called MPI-Serial that aids in testing MPI-based codes on smaller, single-processor systems. To support a greater subset of the MPI standard, functionality for the MPI derived data types has been implemented in MPI-Serial for use with C and Fortran programs. In addition, a test suite has been developed to aid the performance of MPI-Serial that focuses on successful operation of MPI-based programs in a single-processor environment.

Engineering

Analyzing the Response of Frisch-Ring CdZnTe Radiation Detectors. *Najeb Abdul-Jabbar* (*University of Michigan, Ann Arbor, MI*); *Aleksey Bolotnikov* (*Brookhaven National Laboratory, Upton, NY*). Cadmium Zinc telluride (CdZnTe or CZT) is a direct band gap semiconductor that has very promising qualities as a material for gamma-ray radiation detectors. Unlike the traditional high purity Germanium detectors, which require cryogenic cooling, CZT devices have yielded high detection efficiency and exceptional energy resolution while operating at ambient temperatures. This makes them particularly appealing for national security applications such as explosives detection. It is known that CZT detector performance is dependent on two common factors: CZT crystal defects (mainly Te inclusions present in the crystal structure) and surface irregularities that may cause polarization or electric field defocusing. Using infrared microscopy (with

magnification up to x10), Te inclusions on the order of micrometers can be identified. X-ray mapping techniques at Brookhaven's National Synchrotron Light Source (NSLS) are utilized to analyze CZT surface irregularities at a maximum resolution of 10 μm steps. To determine CZT detector performance, pulse height spectra and correlation curves are obtained using Cs-137 and Ge-68 sources. Results show that CZT crystals with a low concentration of Te inclusions measuring greater than ~10–20 μm in diameter consistently yielded excellent spectral response (the best detector tested had an energy resolution of ~1.1%). Polarization was not observed in any of the samples; however an aberrant defocusing effect was discovered that diminished detector energy resolution by roughly 25%. The research involved in this project is part of a general effort to correlate CZT detector performance with the material properties of CZT.

Bio-Oil Stability Increase by Minimizing Ash through Pretreatment. *Dustin Bales* (*University of Missouri – Rolla, Rolla, MO*); *Justinus Satrio* (*Ames Laboratory, Ames, IA*). Bio Oil is created through the fast pyrolysis of biomass process, and can be used for production of commodity chemicals and is being researched as a fuel. Bio-Oil is preferable over biomass as a fuel because it is much more energy dense and easier to transport. Bio-Oil created by fast pyrolysis tends to be unstable in long term storage because the fast pyrolysis process has a short reaction time, which does not allow thermodynamic equilibrium to be reached immediately after production. It has been determined that this is partly due to high alkali ash content. Alkali metals (ash) act as a catalyst in the destabilizing reactions. Hence, alkali reduction causes increased stability. It is hypothesized that certain biomass pretreatments could reduce this alkali content before the sample is pyrolized into bio-oil, specifically boiling water and boiling acid. The objective of this research is to discover what effect these biomass pretreatments have on alkali content. Experiments have been designed to test the ash reduction properties of boiling corn stover for 60 minutes in water and 1%, 2.5%, and 5% phosphoric acid solutions with corn stover biomass feedstock. Samples that have gone through the torrefaction process then the boiling pretreatment will also be used to discover any affect torrefaction has on alkali content. Torrefaction is a low-temperature thermo-chemical pretreatment that breaks down hemi-cellulose in an inert atmosphere and also acts as an excellent drying process. Phosphoric acid is used because of its ability to breakdown hemi-cellulose, hypothetically releasing locked-in alkali and increasing Levoglucosan content. Simple ash analyses of the untreated and treated biomass show a maximum of 52% reduction with 5% phosphoric acid treatment with rinse. Torrified biomass showed a maximum of a 72% ash reduction after a 2.5% acid treatment. Scanning Electron Microscope with Energy Dispersive X-Ray Spectrometry gives a breakdown of the components of biomass ash, char ash, and bio-oil ash. Largest percentages other than oxygen were Silicon, Silicon, and Iron, respectively. Fiber analysis shows a steady decrease in hemi-cellulose with increasing acid concentration. Future work must be done to discover the mechanism by which the Phosphoric Acid removes ash, and to test the pretreated biomass in the actual pyrolysis process.

Design for Increased Functionality of the Hot Cells inside the Radiochemical Engineering Development Center. *Brent Beatty* (*University of Tennessee, Knoxville, TN*); *Jeffrey Binder* (*Oak Ridge National Laboratory, Oak Ridge, TN*). The Radiochemical Engineering Development Center (REDC) has been the United States' main production center for transcurium elements since operations began in 1966. Together with the neighboring High Flux Isotope Reactor (HFIR) these facilities produce transuranium elements for commercial and research purposes. The facilities' technologies and capabilities gained through a vast production history allow for an ideal test bed for Global Nuclear Energy Partnership's (GNEP) Coupled End to End (CETE) demonstration. The purpose of the demonstration is to perform mechanical and chemical processes on actual spent nuclear fuel, which will confirm the projected material flow and performance data and with extensive experimental data. While the specialized support infrastructure for hot cell processing has been in place for forty years, there are still design improvements to the current operational flow necessary to fully accommodate all aspects of the demonstration and to enhance future capabilities of the facility to attract new projects. Many of the cubicles have not been updated in several years and were designed primarily for targets and fuel elements from HFIR. The CETE demonstration will be performed on many different fuel pins and assemblies from many reactor designs. In order to accommodate this larger variety of experimental components, I designed and coordinated fabrication of a new "disconnect well" and the associated "containment thimble" for the remote hot cell welder. These modifications will double the length of components that may be processed in the hot cell. This design adds functionality and increases the flexibility required to process the diverse fuel components with minimal impact on the safety specifications and operational requirements and uses materials that did not require new certification for use in REDC. Due to the increased load that will be on the "disconnect well" flange, a calculation was made confirming the ability of the new design to support the added load. The increased moment of the assembly required an updated seismic analysis which was performed and documented in the facility handbook. As the world accepts Nuclear Energy, facilities like REDC have an important and unique role in demonstrating and validating new advanced chemical processes. There are many additional updates and improvements that will have to be made similar to the redesigned "disconnect well" discussed here in order to fully modernize this key facility.

Development of a Visualization Program Used in Computational Simulations of Nanomaterials. *Jana Black* (*University of Tennessee, Knoxville, TN*); *Peter Cummings* (*Oak Ridge National Laboratory, Oak Ridge, TN*). Nanoscience offers many scientific opportunities; it also poses significant experimental challenges since it deals with matter in the size range of 1 to 100 nanometers. Theory and simulation are crucial to nanoscience since experimental measurements and observations made at the nanoscale are often impossible to interpret without a theoretical model. Oak Ridge National Laboratory's (ORNL's) Center for Nanophase Materials Sciences (CNMS), in particular the Nanomaterials Theory Institute (NTI), is involved extensively in the development of programs and tools for nanoscale simulations at various time and length scales. NTI maintains a high-performance visualization cluster and 16-node visualization wall in addition to its multi-teraflop computational clusters. The goal of this project is to develop a complex tool that can be used to visualize, at high resolution, the trajectories obtained from various types of molecular modeling such as *ab initio*, molecular dynamics, or Monte Carlo. The specific data used as an example in this study is from molecular dynamics simulations of pulling apart a gold nanowire. My role in the project is to write a program to drive two major visualization packages which are already installed on the NTI visualization clusters, VisIt and Visual Molecular Dynamics (VMD), so that high-resolution animations can be created from the simulation trajectories. VisIt is designed to visualize very large parallel data in the terascale range. VMD is designed to visualize molecular biological systems. Neither program is ideal for this project, but both encourage users to modify the source code and/or write scripts so the program will better meet their needs. In this particular study, it was considered best to run the visualization simultaneously with 16 copies of either VMD or VisIt, one per node, using 16 sets of simulation data collected at various conditions. I have written scripts to synchronize them. The scripts label the atoms according to their instantaneous temperatures and vividly display the evolution of the system. The visualization helps to interpret the physical process of pulling apart a gold nanowire at the molecular level. This project serves as a trial step in the molecular visualization of complex systems using the NTI facilities; it is one step toward the ultimate goal of developing comprehensive simulation and animation tools of various stages at CNMS to interpret/guide experimental efforts.

Performance-Based Brake Testing: A Quantitative Analysis of Brake Wear within the Trucking Industry. *Amanda Blagg* (*Pensacola Christian College, Pensacola, FL*); *Gary Capps* (*Oak Ridge National Laboratory, Oak Ridge, TN*). Little is known about the brake performance of commercial motor vehicles within the United States since the current method of inspection is visual and subjective. However, brake life and wear are of great interest to the transportation community, because faulty brakes are both a primary cause of collisions in the trucking industry and a significant expense to trucking companies. In order to assess brake performance, aftermarket brake drums and shoes will be supplied to four industry partners who maintain fleets of class-8 vehicles. Tankers, dry-box vans, dump trucks, and motor coaches will be tested to provide data for each category of heavy vehicles. Each vehicle will be tested on a performance-based brake tester (PBBT) which has been installed at the Greene County Inspection Station on I-81 in Tennessee. Testing will take place at regular intervals varying from weekly to monthly and will continue over the brake life, which may range anywhere from 8 to 18 months. The PBBT's in-ground roller dynamometers will objectively evaluate braking force of each wheel end. Since this braking force is proportional to vehicle weight, artificial axle loading will provide 80% of the gross axle weight rating through hydraulically-operated hooks. As brake force is also dependent upon air pressure, transducers will be used to measure air pressure available in the brake line. To determine wear over brake life,

the thickness of brake pads will also be measured with a caliper and the ovality and eccentricity of brake drums will be measured with a digital indicator before and after the testing period. I wrote the test plan for the experiment, researched equipment used to make initial measurements of eccentricity, and conducted initial tests on the PBBT. The results from this experiment will provide a previously unavailable performance curve for brakes across several industries and will lay groundwork for future studies in which the PBBT may be utilized as a diagnostic tool for faulty brakes.

Development of 40% Energy Saving Home. *Jacob Bonar* (*University of Tennessee, Knoxville, TN*); *Jeffrey E. Christian* (*Oak Ridge National Laboratory, Oak Ridge, TN*). The demand for energy continues to rise throughout the world. One place that everyone can reduce energy consumption is in their home. This is especially true of new homes built with energy efficiency in mind. The goal of my research is to show that a new home can operate with a total energy savings of 40%. The major areas to look closely at are building tightness, appliances installed in the home, and the proper sizing of the Heating, Ventilation, and Air Conditioning (HVAC) system. I will gather the necessary data to prepare a report for the fifth Zero Energy Home, ZEH5. The report concerning only the top floor of ZEH5 will cover how to build a house that has an energy savings totaling 40%. Included in the report detailing ZEH5 will be my write up describing the HVAC sizing using Manual J 8th Edition analysis, which I will conduct for ZEH5. I will work with Jeff Christian to measure and document the airflow rates in ZEH5 distribution system using a flow hood and the whole house air tightness using a blower door. In addition to these sections, an Energy Gauge packet will also be included in the documentation. One major part of the Energy Gauge packet and associated write up will be a comparison between the ZEH5 and the Building America benchmark home. After looking at the energy consumption for a physical year, ZEH5 consumed a daily average of $0.66/day. This is lower than ZEH1-4 homes that consumed between $0.75-$1.01. Two more homes are in development that will continue the research towards a true Zero Energy Home.

Acoustic Array for Wind Turbine Noise Analysis. *Christopher Bonilha* (*Univeristy of Colorado, Boulder, CO*); *Ian Tse* (*Cornell University, Ithaca, NY*); *Patrick Moriarty* (*National Renewable Energy Laboratory, Golden, CO*). Locating and characterizing sources of noise from wind turbines can greatly aid in the design and production of quieter, more publicly accepted machines for renewable power generation. An acoustic array is a device comprised of an arrangement of microphones that when coupled with an algorithm, can locate sources of noise. In 2006, The National Renewable Energy Laboratory (NREL) partnered with the University of Colorado at Boulder to construct a prototype acoustic array as a proof of concept. Issues arose in both the original hardware and software components which needed troubleshooting and correction before the capabilities of the array could be determined. Tests showed that erroneous signals being outputted by the array were caused by the original data acquisition (DAQ) hardware's inability to handle the high volume of data samples. A robust, differential-referenced, simultaneous-sampling DAQ was purchased to replace the old DAQ, resolving the data acquisition issues. The low-quality microphones had inconsistent frequency responses that contributed to the erroneous results. It was also determined that the signal-to-noise ratio could be significantly improved with better microphone arrangements and with the doubling of the number of microphones on the array. The beamforming algorithm that computes the sound pressure levels emanating from a given plane of interest was originally written incorrectly and very inefficiently. A new program was written to perform the beamforming algorithm on the recorded audio signals and produce plots to facilitate easier analysis. Simulations were performed to analyze how array parameters contribute to the performance of the array. After hardware upgrades and the software revisions, the array was subjected to a series of simulations and tests to determine its capabilities. The array was unable to detect a monopole sound source roughly 4 meters away. Further tests should be done on an array with more microphones of better quality and also with a source that is both louder and positioned at probable turbine locations.

Electrical Systems Analysis of Off-Site Groundwater Treatment Facilities to Determine Arc Flash Hazard. *John Boucher* (*Middlebury College, Middlebury, VT*); *Alan Raphael* (*Brookhaven National Laboratory, Upton, NY*). Before an arc flash accident prompted Brookhaven National Laboratory (BNL) to devise the Arc Flash Analysis Project, a project designed to achieve a complete electrical systems analysis of all BNL systems and buildings, many of BNL's older facilities had not been inspected to determine if they satisfied the National Fire Protection Association's "Standard for Electrical Safety in the Workplace" (NFPA 70E–2004). The following study examined the electrical systems of BNL's Off-Site Water Treatment Facilities for their compliance with NFPA 70E–2004 and so was only a piece of the comprehensive Arc Flash Analysis Project. Electrical information such as equipment layout, manufacturing, and operating information for all electrical components such as panels, fuses, and circuit breakers, as well as cable sizes, types, and approximate lengths was obtained by manually inspecting and tracing out the water treatment facilities' electrical systems. Using SKM PTW Power Tools Software (PTW), this information was organized, illustrated, and then analyzed to establish the electrical systems' susceptibility to and energy available for arc flash. The work done for this study produced single-line electrical diagrams via PTW containing all electrical equipment down through the lowest rated panels (480 Volt or 208 Volt) to any 3 phase 480 Volt or 3 phase 208 Volt/225 Amp or greater equipment for the facilities. With the supplied information in the single-line diagrams, PTW was used to compute information such as arc flash incident energy level at each equipment location, the flash protection boundary, and the recommended Personal Protective Equipment (PPE) at these locations. This study sought to achieve greater safety for those working on the concerned electrical systems by providing recommendations for necessary PPE for electrical workers, collecting data to be archived, managed, updated as necessary, and made accessible to facility engineers for future electrical work, and affixing up-to-date arc flash warning labels to all appropriate electrical equipment.

A Comparison between Sludge Sedimentation Rates and Dispersion Characteristics of No. 2 Oil and Biodiesel. *Christopher Brown* (*Clarkson University, Potsdam, NY*); *Thomas Butcher* (*Brookhaven National Laboratory, Upton, NY*). Biodiesel made to American Society for Testing and Material (ASTM) standards, D6751, is a renewable fuel source that within the fuel industry is criticized as being a solvent. When blended with petroleum-based fuels in tanks with contaminants such as carbon deposits, the Fatty Acid Methyl Esters (FAME or biodiesel) are accused of introducing contaminants into solution with the fuel. This leads to filter plugging and fuel starved equipment. In order to attain a greater knowledge of the fuel solvency characteristics of biodiesel, data was collected from testing sedimentation rates, particle size and particle distribution. To test sedimentation rates, clean fuel samples of biodiesel and No. 2 oil were thoroughly mixed with sludge (carbon deposits from No. 2 oil tank bottoms). After being uniformly mixed, each fuel sample was allowed to settle for set time intervals, and then centrifuged. To measure particle size and distribution a laser based optical probe measured the chord length of particles and distribution of particles in solution. When reviewing the sludge particle sedimentation rates, it was evident that the particles required a greater period of time to settle out of the biodiesel fuel sample compared to the No. 2 fuel oil sample. Furthermore, although the settling rate is longer for biodiesel, the same amount of sediment precipitated from the fuel. When analyzing the results from the laser based optical probe, the particle chord length and particle distribution was identical when comparing biodiesel to No. 2 fuel oil. The results that have been gathered imply a significant breakthrough on the industries diagnosis of biodiesel's solvency. The data suggests that biodiesel has the same solvency characteristics as No. 2 fuel oil and that biodiesel is a better dispersant. Biodiesel disperses the sediment particles in the fuel and suspends them longer than No. 2 fuel oil, allowing the contaminants a greater amount of time to be carried to the fuel filter. This finding will allow any necessary changes to be made to in-line fuel filtration.

Electromagnetic Interference from the ILC Beams. *Lavonda Brown* (*Norfolk State University, Norfolk, VA*); *Gary Bower* (*Stanford Linear Accelerator Center, Stanford, CA*). Electromagnetic interference is an emerging problem of the future. This investigation analyzed the data collected from airborne radiation waves that caused electronic devices to fail. This investigation was set up at SLAC in End Station A and the data collected from the electromagnetic waves were received from antennas. In order to calibrate the antennas it required a signal generator to transmit the signals to the antenna and a digital oscilloscope to receive the radiation waves from the other antenna. The signal generator that was used was only able to generate signals between 1.00 and 1.45 GHz; therefore, the calibrations were not able to be completed. Instead, excel was used to create a curve fitting for the attenuation factors that were already factory calibrated. The function from the curve fitting was then used to extend the calibrations on the biconical and yagi antennas. A fast Fourier Transform was then run in Matlab on the radiation waves received by the oscilloscope; in addition, the attenuation factors were calculated into the program to show the

actual amplitudes of these radiation waves. For future research, the antennas will be manually calibrated and the results will be reanalyzed.

***In Situ* Measurement of Stresses in Carburized Gears via Neutron Diffraction.** *Jeffrey Bunn* (*University of Tennessee at Martin, Martin, TN*); *Camden Hubbard* (*Oak Ridge National Laboratory, Oak Ridge, TN*). Carburized gears are characterized by a very hard outer layer that contains chemistry, phase, and microstructure gradients. X-rays have been used in the past to attain measurements of residual stresses, but X-ray diffraction is limited to near surface stress measurements due to attenuation. X-ray diffraction also has difficulty reaching the critical stress regions of a gear tooth due to beam interference from the complex geometry. This research seeks to develop experimental methods for measuring the stresses/strains in carburized gears at locations unattainable by X-rays and to do this as a function of applied load on the gear tooth. Experiments are being performed to determine if neutron diffraction can be used as an alternative to X-ray diffraction to measure the total stresses. Total stresses consist of both the residual stresses imparted during the carburization process and the load induced stresses resulting from power transmission. The experiments are being performed at the Neutron Residual Stress mapping Facility (NRSF2) at the High Flux Isotope Reactor (HFIR). In neutron diffraction, a powder sample is normally used to determine the unstressed lattice spacing or d_0. In carburized components, d_0 can not be determined from a single powdered sample because of the non-homogeneous material in the carburized region. As an alternative to using a powder sample, a method commonly used in X-ray diffraction known as the $\sin^2\psi$ method is being studied to determine if it can be used with neutron diffraction to accurately quantify d_0 in the carburized region. If successful, the $\sin^2\psi$ method will be used to determine d_0 at a number of points in the carburized region. Neutron diffraction methods will then be used to measure the d-space at each of the points for which d_0 was determined. The combination of d-space and d_0 at each point will enable the strains and stresses to be determined at the measurement points. The measurement of the d-space in a loaded gear is being facilitated with a Static Load Application Device (SLAD). This device was designed to statically load the gears as well as be compatible with the equipment at NRSF2. Stress analysis was done on the SLAD to ensure that the device would not exceed strength values found in engineering design standards.

Leak Detection Device. *Elisabeth Byrd* (*Georgia Institute of Technology, Atlanta, GA*); *Dave Lousteau* (*Oak Ridge National Laboratory, Oak Ridge, TN*). When mercury is sensed between the mercury vessel and water shroud in the Spallation Neutron Source target, a leak exists and the target has to be removed from operation. To improve future targets, the front of the target is examined to determine the cause and location of the leak. Most likely, a leak will be visible, but if not, a leak detection device needs to be available. My work was to model and design a leak detection device that would enable the inside of the target to be pressurized while coated with a chemical that will bubble when the air seeps through the cracks, revealing the location of the leak. I was first given an assembly that included a table with a simulated flange serving as the top, which would hold the target. The assembly also included a lid that is placed on the top of the target to seal it. The entire leak detection device will be radioactive after use; therefore, one goal is to minimize the amount of material when designing the assembly. There is a boot already in the hot cell, which was made to provide shielding for the front end of the target when it is being removed. I used this boot instead of the table so that no waste would be created and nothing new would have to be designed or manufactured with the exception of a part connecting the flange to the boot. This new part was designed to accommodate the racetrack shape on the top of the boot and the circular shape of the flange. The initial adapting part model used a blend from the racetrack shape to the circular top. Unfortunately, this direct approach would be both difficult and expensive to manufacture. I then modeled a more manufacturing friendly part using the racetrack shape as the dominant feature and then attached wings on the top to accommodate the circular flange. This way, the manufacturer could use sheet metal to form the racetrack shape and then weld a piece of sheet metal to the top, which would form the wings. The stress on the part was calculated using the finite element analysis tool, Mechanica. Mechanica indicated that it can withstand loads much greater than the 900-pound force that will be applied from the weight of the target and seal assembly. In addition to learning a new modeling program, this challenge taught me to include from the outset design concerns for manufacturing, robot assembly, and end waste management.

Surveying and Mapping for a Localized GIS. *India Calhoun* (*Savannah State University, Savannah, GA*); *Brian Fuss* (*Stanford Linear Accelerator Center, Stanford, CA*). The Alignment Engineering Group (AEG) is responsible for an extensive array of alignment and positioning activities at the Stanford Linear Accelerator Center (SLAC). In particular, the location of accelerator components using specialized tools and data adjustment procedures are the center mission(s) of the group. My established goals for this project are to accurately measure a set of buildings known as Forte Apache to produce a 3-dimensional CAD drawing that will be used to create a 2-dimensional Geographic Information Systems (GIS). Computer Aided Design (CAD) is the use of a wide range of computer-based tools that assist engineers, architects and other design professionals in their design activities [5]. Overall, in the project, I will construct a 2-dimensional GIS that can be used to analyze relationships between features.

Assessment of a Residential Style Oil-Fired Boiler as a Host for a Thermophotovoltaic Combined Heat and Power System. *Julian Carpenter* (*Alfred State College, Alfred, NY*); *Thomas Butcher* (*Brookhaven National Laboratory, Upton, NY*). Combustion of number 2 heating oil is intrinsically emissive, more so than natural gas, propane or butane. Therefore, oil combustion is a good candidate for power generation using thermophotovoltaic (TPV) cells. In order to test the viability of current residential oil heat technology as a host for TPV combined heat and power generation (CHP), a prototype oil fired TPV CHP system must be built, tested, and characterized. Previous work has shown potential for sufficient power densities using a small 1 cm^2 GaSb TPV array with a residential boiler, however, the effects of the much larger array (99 cm^2) on achievable power density, and the effects of system geometry, firing rate, combustion conditions and the use of silicon carbide (SiC) emitters is not known. One small and one large (99 cm^2) GaSb TPV arrays were tested with various configurations in a modified residential style boiler capable of firing at 0.5 to 0.85 gallon per hour (gph). The use of a reticulated SiC emitter as well as the effect of firing conditions, burner output, and system geometry were varied and measurements of short circuit current (Isc) and open circuit voltage (Voc) were taken to measure power output. It was determined that a large pore SiC foam emitter improved power output, although the pressure drop across the foam plate was problematic. Varying the distance from cell to emitter, the size of the cell, boiler combustion chamber insulation, amount of excess air, and firing rate were found to substantially impact the power output of the TPV cell. Power densities of approximately 1.3 W/cm^2 were achieved with the single cell array, and 0.85 W/cm^2 with the 99 cell array. Future work should investigate ways to boost power output to over 2 W/cm^2, in an effort to provide more than enough power for a stand-alone oil fired boiler TPV CHP system.

Use of RF and Digital Signal Processing for Beam Position Monitoring. *Sara Carr* (*Rochester Institute of Technology, Rochester, NY*); *John Musson* (*Thomas Jefferson National Accelerator Facility, Newport News, VA*). A Beam Position Monitor (BPM) is a useful device because it accurately detects the location of an electron beam at very low current. A BPM coupled with a Beam Current Monitor (BCM), located in Hall A of the Continuous Electron Beam Accelerator Facility (CEBAF), originates the analog signal on three channels: an X-position, a Y-position, and a current channel. The BPM detects the output voltage proportional to the product of current and position, while the BCM detects the voltage proportional to current. It was believed that the quotient of the two signals would result in the position of the beam. The purpose of this project was to attain a good resolution by optimizing signal-to-noise ratio; this was accomplished by limiting the bandwidth of the noise. With the use of RF signaling and digital filtering, the bandwidth was configured using a Field Programmable Gate Array (FPGA), a small integrated microprocessor. Using Altera Analog Hardware Description Language (AHDL) a coded block diagram of digital logic was programmed onto the chip. Once the bandwidth was limited to the desired frequency, the current channel was divided into the X-position channel resulting in the beam's position on that plane. It was shown that a low current run of 50 nA could be detected with 100 µm of resolution by limiting the bandwidth to 5 kHz. This was accomplished with a series of digital filters that were able to cut the frequency with a method called decimation. In order to detect different magnitudes of current, there was a second filtering path with a bandwidth of 100 kHz, that measured current runs up to 40 µA. The design of the system can easily be tailored to the needs of Users by implementing different firmware to the FPGA, which is both time and cost effective.

Oxidation Characterization and Resistance of Nb-Cr-W Super Alloys at Elevated Temperatures. *Daniel Castro* (*University of Texas at El Paso, El Paso, TX*); *Ken Natesan* (*Argonne National Laboratory, Argonne, IL*). The importance of turbine engines in aerospace and energy sectors of industry has lead to the research of high temperature low oxidation super alloys for turbine engine component fabrication. An interest in niobium based super alloys has developed because of its high service temperature capability and oxidation resistance when alloyed with chromium and tungsten. The goal of this project is to evaluate Niobium based super alloys when exposed to high temperatures. Samples from two separate alloy compositions were oxidized at temperatures ranging from 700°C–1,400°C. The characterization of the oxide layers of the samples was critical due to little or no research performed on the oxide scale of Nb-Cr-W super alloys. It was thought that the primary oxide formed on this alloy after high temperature exposure was Nb_2O_4, however, Nb_2O_4 carries a distinct geometrical shape (spherical and cylindrical) but oxides of a different geometry and chemical composition were identified. By using a JOEL JSM-6400 Scanning Electron Microscope (SEM) and Energy Dispersive X-ray Spectroscopy (EDS), the oxides on the alloys were characterized as being chromium rich as opposed to niobium rich (Nb_2O_4) in previous alloys with less chromium in the initial chemical composition. The identified oxide layer has never been seen previously and carries no distinct geometrical form, rather, it has a scale type of appearance. The oxide layer appears only at the surface of the metal samples because these are the only areas exposed to oxygen during heat treatment. With an increase in exposure temperature, the oxide becomes more pronounced under the SEM and the oxide layer penetrates deeper into the sample thus reacting with more chromium in the metal. In the resolve of this research, identifying a new oxide formation and mechanism has affirmed the need for more oxidation research in Nb-Cr-W alloys. Future study on the chromium rich oxide layer and its mechanical properties will determine the feasibility of the Nb-Cr-W super alloys in turbine engine components.

Sampling and Analysis Methods for Microbial Fuel Cells. *Scott Cesar* (*Western Michigan University, Kalamazoo, MI*); *Abhijeet Borole* (*Oak Ridge National Laboratory, Oak Ridge, TN*). Microbial Fuel Cells (MFC's) are devices which use micro-organisms as catalysts to oxidize compounds such as glucose whereby electrons are released and are allowed to flow between electrodes developing a potential difference from which usable power may be drawn. MFC's are quite simple when viewed yet quite complex when analyzed. Many factors need to be steadily sampled and analyzed to determine different parameters within the system. Direct monitoring of system electrical characteristics with a voltmeter gives open circuit voltage (OCV) and current output at a given load. A variable-load resistor was employed to obtain a power density curve in which overall power of the system was determined. The most recent method involves electrode cycling to obtain higher output of the total system. Along with electrical measurements, samples of anode and cathode solutions are taken to determine the performance of the MFC's. Spectroscopy was used to derive optical density measurements for determining cell concentrations and also for determining differing iron concentrations in solution. The solution pH was also monitored for biological stabilization. High Pressure Liquid Chromatography (HPLC) was used for glucose and organic acids analysis. The results have shown that a mediator was required for conduction of electrons from the microbes to the electrode surface under the conditions tested. Iron was used as a mediator, since it is cheaply available. From iron analysis, it was found that iron (III) is electro-sorped on the electrode surface after electron donation. Electrode cycling was used to maximize power output under these conditions. Further work to facilitate increased rate of iron desorption is needed to enable stable power output.

Evaluation and Recommendation of Advanced Laser Power and Laser Energy Meters for Potential Acquisition. *Timothy Cheers* (*Southwest Tennessee Community College, Memphis, TN*); *Mark Ludwig* (*Lawrence Livermore National Laboratory, Livermore, CA*). Lasers are powerful research tools but pose significant safety issues if not monitored and controlled appropriately. The ever evolving world of technology has developed smaller, more advanced meters used to monitor power-energy emissions from lasers. These devices are called laser power and laser energy meters. The Hazards Control Department (HCD) uses power and energy meters to verify output of lasers, reclassify lasers as needed, and conduct accident investigations should one occur. Due to their safety applications, the HCD power-energy meters are calibrated to National Institute of Science and Technology standards and are an integral component of Lawrence Livermore National Laboratory's (LLNL) laser safety program. LLNL HCD has not updated these meters for many years. The purchase of updated equipment would enhance HCD's capability and efficiency in supporting LLNL laser users in the performance of critical laser measurements. The newer more advanced power-energy meters were researched and companies solicited for loaner units. A test plan and meter rating spreadsheet tool was developed for evaluating the instruments based on their capability to meet LLNL laser system performance needs (e.g., maximum power-energy levels, total range, pulse width, and laser repetition rate). The usability factors as determined by the researchers, compatibility with LLNL data transfer devices, cost, maintenance and calibration requirements, performance history at other facilities, etc. were taken into account. Three companies arranged to loan units for LLNL's evaluation. Limited testing with researchers was completed on the units received. Based on the rating results and budget constraints, a single laser power and energy meter was selected. Using this rating spreadsheet, selecting the most suitable meter has become a more efficient and valid process, which will be useful for future meter evaluations. This work was performed under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

Effective Queue Distributions in Video Streaming: A User Perspective. *R. Benjamin Clay* (*Virginia Tech, Blacksburg, VA*); *Sami Ayyorgun* (*Los Alamos National Laboratory, Los Alamos, NM*). Queuing theory and buffer control are areas of great interest as networks become large and unmanageable. Specifically, guaranteeing a quality of service (QoS) in a large, uncontrolled network such as the internet is important from both a business perspective (selling a service at a specified QoS) and a user perspective. In order to ensure that data reaches the intended target at the intended rate, stochastic rate control algorithms can be used to guarantee a service within a given probability. To this end, previous work has determined and elaborated upon mathematical methods to achieve optimum buffer control given a generic packet-based data source. Our work extends these algorithms to streaming video, using subjective analysis to determine the appropriate equations and values to make the rate control transparent to the end user. To do so, a server-client implementation has been built on top of the popular opensource video player (VLC). The rate control algorithms specified in previous work are built as the core of the server application, modifying VLC's User Datagram Protocol (UDP) streaming server component. The client is another copy of VLC, operating as a UDP streaming client. Preliminary results indicate correlation between decay rate and video quality for those distributions that employ a decay rate.

Friction Factors Appropriate to the Application of Ultra-Filtration to Radioactive Waste. *Adriana Contreras, Marc Stevens* (*Nicholls State University, Thibodaux, LA*)*; Reid Peterson* (*Pacific Northwest National Laboratory, Richland,WA*). The U.S. Department of Energy's Hanford Site was developed during World War II to produce weapons-grade plutonium. This and other activities resulted in 60,000 metric tons of waste stored in 177 underground storage tanks (UST). Some of these USTs have leaked into the subsurface. Because of this and other environmental concerns, DOE and Bechtel National, Inc. (BNI) are designing a Waste Treatment and Immobilization Plant (WTP) to treat the radioactive waste. A critical element of the WTP is an ultra-filtration process (UFP) that separates the radioactive slurry into high-level waste (HLW) and low-activity waste (LAW) forms. However, the productivity of the UFP in terms of HLW and LAW is in question and one approach to addressing production maximization is to understand the conditions to maximize permeate rates. This is predicated on understanding the relationship between axial velocity and pressure drop, which is the subject of this research. There are several approaches to modeling v versus Δp. For example, researchers at Savannah River National Laboratory compared the Blasius model to experimental data collected from the Filtration Research Engineering Demonstration apparatus. They observed that the Blasius model under-predicted the data. Our approach is to use the Darcy-Weisbach equation, which includes a friction factor that has been determined using Prandtl's Mixing-Length Theory. The friction factor is a function of Reynold's number (Re) and a parametrically defined coefficient B. This B coefficient is possibly a function of several non-dimensional numbers. The results show that the appropriate model for B is a function of Cp (coefficient of pressure) and length divided by diameter. Our results also show that one model works well for a particular apparatus when treating diluted slurries, but it is not as effective when applied to more prototypical slurries. Different models are developed for more prototypical slurries on the 07 Cell Unit Filtration Systems for low and high solids, which may be an influence of the fluids behavior from Newtonian to non-Newtonian. Through our understanding of this basic science, a better knowledge base will be formed to assess the productivity of the UFP, which helps the Pacific

Northwest National Laboratory's goal to give research and development support to DOE and BNI.

Optical Detection Techniques of Solid and Liquid Explosives. *Christopher D'Ambrose* (*Cooper Union, New York, NY*); *Biays Bowerman* (*Brookhaven National Laboratory, Upton, NY*). Explosives present a current threat for both soldiers and civilians. Therefore, it is necessary to possess the ability to detect both solid and liquid explosives. It is also important to be able to detect the explosives from a safe distance in order to minimize the risk of injury or even death. This research paper focuses on the standoff detection of explosive materials by using optical techniques, such as some of the various methods of Raman spectroscopy and light detection and ranging (LIDAR). Raman involves excitation of a sample with a laser and subsequent measurement of scattered radiation that is dependent on vibrational states of the molecules of interest. LIDAR requires a light source that transmits radiation to a target and then measures the time difference of backscattered radiation in order to identify the location of the substance. Variations of the LIDAR technique can be used for chemical identification. The Internet provided some of the literature for the research on this topic. The types of websites that were used include science websites, government websites, military websites, and online news articles. Also, companies that design and sell explosive detection devices supplied the specifications of various products that are commercially available. Books from the Research Library at Brookhaven National Laboratory provided technological descriptions of Raman spectroscopy and LIDAR. Scientific journals contributed valuable information on the use of Raman spectroscopy and LIDAR for explosive detection. This research paper is a collection of useful information about explosive detection in order to make this topic easier to understand and quicker to learn about. The main purpose of this research was to explain the advantages and disadvantages of both Raman spectroscopy and LIDAR in the area of standoff explosive detection. Therefore, the reader is able to analyze the possibility of the future development and the field deployment of these detection techniques.

Ensuring Co-planarity of Tiled Optical Surfaces. *Michael Dawson-Haggerty* (*Tufts University, Medford, MA*); *Paul O'Connor* (*Brookhaven National Laboratory, Upton, NY*). The Large Synoptic Survey Telescope (LSST) is designed to have an extremely large field of view, 9.62 square degrees, nearly 50 times the area of the full moon. The digital camera used to record the images provided by such a large field needs to be enormous. The focal plane of the camera is a circular area 60 cm in diameter, covered in a tiled surface of 4 cm square CCD imaging chips, which provide the digital image for analysis. Although the area is large, the tiled sensors need to be coplanar to within plus or minus five microns, as the light is converging on a very specific, precise point. To do this, the tiles are grouped into 3x3 arrays called 'rafts' which can be constructed individually. The rafts are scanned with a laser confocal displacement meter mounted onto an x-y gantry system. The displacement meter is scanned over the raft surface, and a 3D model can be made of the raft. Tilt and vertical displacement of each CCD can be assessed, and extremely thin foil shims of known thickness can be inserted to compensate. The scan is repeated until all silicon sensor surfaces are within tolerances. This allows the effectiveness of thin- foil spacers to be assessed, as well as the overall feasibility of the precision requirements for the tiled surface, a greater precision then has been attempted previously. This work is a small portion of a much larger project being researched to develop the LSST optical and mechanical systems, and once completed will play a large part in ensuring a clear and focused image.

Hexapod as a Goniometer System. *Michael Dibiccari* (*Rensselaer Polytechnic Institute, Troy, NY*); *Elaine Dimasi* (*Brookhaven National Laboratory, Upton, NY*). A hexapod is a device consisting of two platforms conjoined by six diagonal legs of variable length. By changing the lengths of these legs, it is possible for the upper platform to experience independent or simultaneous translation in any of three dimensions, as well as independent or simultaneous changes in roll, pitch, or yaw. A hexapod mounted atop a rotation stage can be a viable replacement for the three or four ring goniometer systems being used for small angle X-Ray scattering experiments at the National Synchrotron Light Source (NSLS) at Brookhaven National Laboratory (BNL). For this project, these legs consist of ultra-high-vacuum (UHV) rated piezoelectric nanostepping linear motors, which are monitored by optical encoders. The hexapod system in this project is mounted to a rotation stage which is also manipulated by UHV rated piezoelectric nanostepping motors. The manufacturer of this hexapod claims up to 5nm precision for the motors, 50nm precision for its upper platform, a 28mm linear working envelope, pitch yaw and roll range of ±18°, and maximum Z stroke of 55mm. This hexapod system manipulates roll, pitch, and yaw similarly to an eulerian cradle, where axes of rotation for successive rotations are carried on in an enforced order of rotations. In this way, rotation commands sent to this hexapod commute; the order in which they are issued does not effect the resulting position of the sample stage on the top platform. This hexapod system is controlled as a socket device through Certified Scientific Software's SPEC X-Ray Diffractometer software interface. This interface is currently used to control other devices at the NSLS at BNL including the four-ring euler cradle this hexapod system is being designed to replace. The hexapod and rotation stage goniometer system is to be implemented in the beamline X9 of Brookhaven National Laboratory's NSLS. This system is also very promising for the upcoming NSLS-II. Because the NSLS-II beam cross-section is very small, great care must be taken to assure that the sample does not shift out of the beam path during the experiment. A hexapod system such as this has rarely been used as a goniometer system, and should allow for increased precision over the three or four ring goniometer system currently in use for small angle X-Ray scattering experiments.

Characterization of a Mobile Oscillatory Fatigue Operator for Wind Turbine Blade Testing. *Pearl Donohoo* (*Franklin W. Olin College of Engineering, Needham, MA*); *Jason Cotrell* (*National Renewable Energy Laboratory, Golden, CO*). Laboratory testing of wind turbine blades is required to meet wind turbine design standards, reduce machine cost, and reduce the technical and financial risk of deploying mass-produced wind turbine models. Fatigue testing at the National Wind Technology Center (NWTC) is currently conducted using Universal Resonance Excitation (UREX) technology. In a UREX test, the blade is mounted to a rigid stand and hydraulic exciters mounted to the blade are used to excite the blade to its resonant frequency. A drawback to UREX technology is that mounting hydraulic systems to the blade is difficult and requires a relatively long set-up period. The author has analyzed an alternative testing technology called the Mobile Oscillatory Fatigue Operator (MOFO). The MOFO uses an oscillating blade test-stand rather than a rigid stand, avoiding the need to place hydraulic systems on the blade. The MOFO will be demonstrated by converting an existing test-stand at the NWTC to an oscillating stand that can test blades up to 25 m in length. To obtain the loads necessary to design the MOFO, the system motion is modeled using rigid body and lumped mass dynamics models. Preliminary modeling indicates the existing stand can be converted to a MOFO relatively easily. However, the blade dynamic models suggest that blade bending moment distributions are significantly different for UREX and MOFO testing. More sophisticated models are required to assess the implication of this difference on the accuracy of the test.

Four-Cylinder, 22L Direct-Injection, Omnivorous Engine Project. *Emily Dringenberg* (*Kansas State University, Manhattan, KS*); *Steve Ciatti* (*Argonne National Laboratory, Argonne, IL*). Concerns associated with petroleum dependency, increasingly stringent emission standards, and the effect of personal transportation on our environment demand that researchers explore the capabilities of renewable energy sources. Ethanol is a fuel of primary investigation; it is being looked to as a promising step toward energy independence. Related research is being done in the Transportation Technology R&D Center at Argonne National Laboratory where researchers are using an Opel 2.2L EcoTec Engine (GM L850) to study variable ethanol-gasoline fuel blends and their effect on engine performance, efficiency, and emissions. The in-line 4-cylinder GM engine is designed to run on gasoline fuel. It has not been altered to run using ethanol fuel, but the cylinder head has been modified to include a pressure transducer for each cylinder. The pressure transducers directly measure the pressure in each combustion chamber. Heat release analysis, which characterizes combustion behavior, can be derived from these pressure measurements. Additional sensors measure other engine variables, such as temperatures, pressures, and flow rates. A Horiba MEXA-7100D emissions bench is being used to analyze the engine-out emissions. Preliminary data relating to engine performance, efficiency, and emissions for gasoline, E10 (10% ethanol and 90% gasoline by volume), and E20 have been collected, and data for E50 and E85 will follow. From this preliminary information, general trends regarding fuel consumption, engine efficiency, and emissions were observed. With increased amounts of ethanol, improved engine efficiency and a reduction in mid-load emissions were observed. Using this information as a baseline, researchers hope to continue research to find an optimized configuration for different fuel blends.

Heavy Truck Duty Cycle Data Collection. *Fiona Dunne* (*University of California – Santa Barbara, Santa Barbara, CA*)*; Gary Capps* (*Oak Ridge National Laboratory, Oak Ridge, TN*). Real-world data on Class-8 truck operation is necessary for fuel efficiency studies as well as for use in vehicle powertrain design software. To gather this data, six Class-8 trucks were instrumented with a data acquisition system (DAS) and a set of sensors to monitor numerous vehicle performance parameters from engine to tires, as well as weather conditions, road slope, and load weight over a one year period. First, the truck's J1939 vehicle network was tested to learn what vehicle performance information was available on it, and how to retrieve the data of interest. The other sensors and DAS were then installed on each truck, and all data was recorded to the DAS as the trucks then continued in regular operation. During operation, data was checked weekly for errors to determine whether the equipment was functioning correctly. By checking the data, it was discovered that weather sensors began failing from water entry due to unexpected pressure washing of the trucks. Load weight data was found to be inaccurate, as truck drivers had not correctly calibrated the weighing system. Road slope and vehicle network data results were as expected. It was concluded that weather sensors should be covered during pressure washing, and an alternative method for calibrating the weighing system was devised. It was also concluded that the method used to obtain road slope, a derivation from GPS vertical and ground velocity data, was adequate. Finally, it was determined that no changes needed to be made in the method of communication with the vehicle network. Data will continue to be checked for errors throughout the remainder of the one year test, and changes will be made as necessary.

Determining the Ability to Monitor the Viability of Transplant Rat Glioma Cells with an Optically Enhanced Catheter. *Rachel Dyer* (*St. Olaf College, Northfieldm, MN*)*; Boyd M. Evans III* (*Oak Ridge National Laboratory, Oak Ridge, TN*). Approximately fifty thousand cases of Parkinson's Disease are diagnosed within the United States each year. This debilitating disease results from the dissolution of dopamine-dependent communication between the substantia nigra and the striatum of the brain. Cellular replacement therapy, in which stem cells are introduced to supplant dead or stressed cells, has shown promise in animal models. However, the viability of transplanted cells and their survival rate is poorly accounted for by early tests. A novel design coupling a surgical catheter with fiber optic technology provides a tissue delivery platform that can monitor cell viability with sensing techniques widely accepted in the medical industry. The goal of this work is to monitor the health of transplant cells in real time at the final point of delivery using the optically enhanced catheter. Rat glioma cells were separately labeled with CellTracker Orange (CTO) (Invitrogen) and JC1 stain from BioVision's MitoCapture Mitochondrial Apoptosis Detection Kit and fluorescence was characterized by confocal microscopy. CTO exhibited a single emission peak at 570 nm upon excitation with a 488 nm argon laser. JC1 exhibited two emission peaks corresponding to fluorescence of viable cells and apoptotic cells, 595 and 540 nm respectively. JC1 was used to monitor the viability of cells under apoptotic conditions induced by incubating JC1-labeled cells with carbonyl cyanide 3-chlorophenylhydrazone or etoposide. Observation of fluorescence using a mercury fluorescence microscope over a four hour period demonstrated JC1's ability to shift in color to reflect cell viability. To detect cell movement through the catheter, cells were labeled with CTO, excited by an argon ion laser with a 501 nm wavelength and a peak emission at 570 nm was detected by an Ocean Optics spectrometer. JC1 was also used to detect the movement and the viability of cells through the catheter. Cells excited by an argon ion laser with a 488 nm wavelength exhibited emission peaks at 540 and 595 nm, demonstrating the ability to detect both viable and apoptotic cells at the final point of delivery. From the detection of rat glioma cells labeled with CTO and JC1 using the diagnostic catheter, and the characterized response of JC1-labeled cells to apoptotic conditions, it can be concluded that these fluorescent probes are suitable for tracking and monitoring the viability of transplant cells through the optically enhanced catheter.

Superconducting Magnets. *Aly Elayat* (*University of Illinois, Urbana, IL*)*; Juan Lizarazo* (*Lawrence Berkeley National Laboratory, Berkley, CA*). Supercon is a research group that deals with the fabrication of superconducting magnets. One of the goals of the group is to upgrade the Data Acquisition System (DAQ) to increase flexibility for the user and get more precise results while testing. The DAQ includes the Strain Gage System which is used to examine fluctuation in temperature and pressure that occur while testing the magnet. Several voltage taps are located on the coils which monitor the voltage drop across a certain resistance that helps us identify such fluctuations. Keeping the fluctuations at a minimum is an ideal goal of the group. Supercon was looking to build a switch box that enables the user to supply current to numerous strain gages located on a magnet. I had to design this switch box to be user friendly, cost-effective, and meet all specification needed. The design provides the flexibility that allows the user to use up to 12 current sources to supply power to multiple daisy chained strain gages. This flexibility allowes more precise results while testing. Researches can now supply current to specific strain gages located on the magnet to measure their fluctuations in temperature and pressure.

***An Assessment of the Implications of 10CFR851 on the Vacuum Systems at the National Synchrotron Light Source.** *Michael Espinoza* (*State University of New York at Stony Brook, Stony Brook, NY*)*; Ed Haas* (*Brookhaven National Laboratory, Upton, NY*). As of February 9, 2007, the U.S. Department of Energy required that its facilities are compliant with Section 10 of the Code of Federal Regulations, part 851 (10CFR851). One of the new rules is the requirement to treat vacuum vessels as pressure vessels due to their susceptibility to backfill pressurization. The consequence of treating vacuum vessel as pressure vessels is that they must potentially comply with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Codes which formerly were not used for vacuum systems, specifically Section VIII of the B&PV code. At the National Synchrotron Light Source, electrons circulating in the accelerators produce photons in the beam lines for research. The electrons and photons are contained within vacuum chambers and beam pipes. Most beam line segments having sources of pressure, such as water or a gas, and were inspected to see if added safety devices were needed. If needed, ASME-compliant safety devices shall be identified, sized, and located according to ASME code. All of these codes are divided into smaller sub-sections, in which only some are applicable to vacuum systems. These codes require safety pressure relief devices on vessels where over-pressurization could result in a failure mode. After developing and programming the necessary equations using Excel spreadsheets, a study of each beam line was undertaken. Of highest concern were pressure sources that penetrated into the vacuum space within components such as monochromators, slits, and beryllium windows. Cooling water sources connected to make-up water, nitrogen, helium, and process gas sources were examined and the pressure and flow information was calculated. Each isolatable section with a potential pressure source required a pressure relief device. Within each segment, the weakest component was generally identified. Glass view ports and beryllium windows for example were usually the components which would be expected to fail at the lowest internal pressure. The spreadsheet calculated the pressure relief requirements and output graphs of flow rate and pressure verses time. This effort assures that NSLS is compliant with 10CFR851 and its vacuum systems are safe.

Effects of Humidity in Inlet Air on a Proton Exchange Membrane (PEM) Fuel Cell. *Andrew Fasano* (*Farmingdale State College, Farmingdale, NY*)*; Devinder Mahajan* (*Brookhaven National Laboratory, Upton, NY*). Air humidification plays a crucial role in the performance of polymer electrolyte membrane (PEM) fuel cells. The present study aims to determine the effect of relative humidity on the cathode side that will produce optimal fuel cell performance at various power levels. Usually, increasing air humidity improves fuel cell performance until it reaches an optimal operating condition. If humidity continues to increase beyond this point, the fuel cell experiences flooding due to the isolation of the catalyst surface from the reactant gases which causes considerable power degradation of the fuel cell. The recorded data shows that air humidification at relatively low temperature levels tends to hinder the cell performance due to its saturation with water. When current levels are increased, an increase in inlet air humidity causes the cell to initially drop in performance due to a certain degree of catalyst flooding at low temperature. However, as the cell begins to increase in temperature, the humidification of inlet air results in a slight recovery of power in the cell output. In conclusion, at room and low temperatures humidification of the inlet air to the PEM fuel cell exhibits a negative effect on the cell power output due to partial flooding. But as the fuel cell continued to operate, the temperature increased that allowed the initial flooding to subside and power escalation was observed.

Effect of Chemistry on the Life and Performance of High-Power Lithium-Ion Cells. *Magdalena Furczon* (*University of Illinois at Chicago, Chicago, IL*)*; Daniel Abraham* (*Ames Laboratory, Ames, IA*). High-power battery technology is key to the commercial success of hybrid electric vehicles (HEVs). These vehicles combine the advantages of the extended driving range and rapid refuelling capability

of a conventional vehicle with the increased fuel economy and reduced exhaust gases of an electric vehicle. The relatively high specific-energy and specific-power characteristics of rechargeable lithium-ion batteries make them an attractive alternative to the nickel metal-hydride batteries used in hybrid vehicles currently in the market. The goal of this project is to determine the suitability of various electrode-electrolyte combinations for HEV applications. The cells typically contain a layered oxide-based positive electrode, a graphite-based negative electrode, and an electrolyte containing an organic solvent and lithium-bearing salts (such as $LiPF_6$). Project activities to date have involved investigation of the effect of alternative salts, such as $LiF_2B(C_2O_4)$ and $LiB(C_2O_4)_2$, on cell cycling performance. Experiments were conducted on ~2 mAh coin cells and on ~35 mAh cells containing a lithium-tin reference electrode. The cells were electrochemically cycled or subjected to above-ambient temperatures (up to 55°C). Capacity and impedance measurements were made periodically to determine the deterioration of cell performance with age. Initial data indicate that cells containing the $LiF_2B(C_2O_4)$ salt show better long-term performance than do cells containing the $LiPF_6$ and $LiB(C_2O_4)_2$ salts.

Electrolysis and Pressure Driven Flow for Temperature Gradient Focusing. *Ellis Garai* (*University of California – Los Angeles, Los Angeles, CA*)*; Kevin Ness* (*Lawrence Livermore National Laboratory, Livermore, CA*). Bio-warfare detection systems are a necessary means of maintaining national security. In order for a detection system to be practical and largely deployed it should be easy to use, affordable, portable, low power, rapid, accurate, and autonomous. Currently, bio-warfare detection instrumentation do not meet the aforementioned specifications due to the lack of automated front-end sample preparation(FESP). FESP consists of purifying, concentrating, and separating 'complex' environmental samples in order to improve the downstream detection assays performance. Temperature gradient focusing(TGF) has been identified as a novel microfluidic technique to aid in the necessary autonomous FESP. TGF is the balance of an advective flux and an electrophoretic flux, in the presence of a temperature gradient, to ensure focusing only occurs at a unique spatial location along the axis of the microchannel. The main factors influencing the stability during TGF are a stable flow field and a stable electric field within the microfluidic system; therefore, these parameters must be tightly controlled. Electrolysis greatly influences these parameters; any gas formation within a channel can perturb both the flow and at the very least perturb the electric field. An in-line gas management system was devised to overcome this obstacle. Several approaches were taken to address this issue. The first was to remove the gas forming at the electrode through a porous gas permeable Teflon material while under vacuum. The second consisted of a large sealed air/liquid electrode reservoir, through which bubbles would float to the surface. With certain disadvantages in the first two, a final, more promising approach to directly isolate the gas formation was chosen. By using a proton permissible material (Nafion), gas generated at the electrode is isolated from the TGF flow line and swept down a separate line using a constant running buffer. In addition to electrolysis altering the flow field, generating a stable flow at the ~100 nL/minute range was another hurdle. Commercial pumping technology has an ~10% variation in the flow rate at any given time. By using a high resolution flow sensor and a dynamically controlled pressure source, in combination with a custom PID control scheme, a stable flow rate of less than 1% change (~1 nL/minute) was attained. Through this tighter control over important TGF parameters improvements in purification, separation, and concentration effects are realized.

Practical DNA-based Clinical Diagnostics. *David Geb* (*University of California – Los Angeles, Los Angeles, CA*)*; Torsten Staab* (*Los Alamos National Laboratory, Los Alamos, NM*). The development of a disposable test cartridge for DNA-based clinical diagnostics will afford a better alternative to current protein-based tests. DNA-based clinical diagnostics is significantly more accurate than the protein-based alternative. Moreover, a cheap, effective, disposable test cartridge will allow this technology to be accessible to more patients. The development of this test cartridge involves designing, prototyping, assembling, and testing its mechanical components. After the completion of the project, a user-friendly, affordable, and accurate device will be the result. Its technology will provide a solution for clinical diagnostics in physician offices worldwide.

Scrubbing of Sulfur Dioxide Byproducts of a Hydrogen Production System. *Lindsey Goodman* (*Georgia Institute of Technology, Atlanta, GA*)*; Greg Krumdick* (*Argonne National Laboratory, Argonne, IL*). The design of an SO_2 scrubber was necessary for a hydrogen sulfide (H_2S) to hydrogen conversion system that is currently being developed at Argonne National Laboratory. It has been previously shown that hydrogen can be produced by reacting hydrogen sulfide (H_2S) gas with a molten metal, producing sulfur dioxide (SO_2) as a byproduct. Because large quantities of SO_2 will be generated by this new conversion system, a method had to be devised to further break down this compound into environmentally neutral substances. The process of SO_2 removal is called Flue Gas Desulfurization, or scrubbing, and is done with an apparatus called a scrubber. Described in the following paper is the process engineering of this small scrubber system. A wet Venturi ejector type system was chosen. A liquid jet eductor nozzle was implemented as the scrubbing device. The chosen scrubbing reagent was a solution of 20% concentration of sodium hydroxide (NaOH, or caustic). A heat exchange system was employed to ensure the correct operating temperature. Control methods were used to ensure proper concentration of NaOH solution. It was estimated that for one six hour batch of the H_2S conversion process, the scrubber will remove approximately 200 pounds of SO_2, generate about 282,000 BTU of heat, and consume roughly 130 gallons of 20% caustic solution. Once the H_2S conversion system is complete, the scrubber will be tested and adjusted accordingly.

Binding Superhydrophobic Powder to Surfaces for Dielectric Purposes. *Mary Hadley* (*Vanderbilt University, Nashville, TN*)*; Enis Tuncer* (*Oak Ridge National Laboratory, Oak Ridge, TN*). Outdoor insulators used in high voltage transmission lines and substations are constantly under environmental stress leading to power interruptions, flashovers, etc. One common occurrence in polluted areas is excess water collecting on insulators promoting dry band arcing. It has been shown that hydrophobic materials are the solution to avoiding this event. These materials do not interact with water molecules forcing them to bead up instead of collecting into films. This unique surface quality also makes the hydrophobic materials self-cleaning in wet environments. Traditional hydrophobic materials for outdoor insulation have been silicone rubber based materials. Recently other material formulations with fluor based compounds have been proposed. In this study, a superhydrophobic (SH) material made of a glass-based powder is investigated. The material alone does not adhere to surfaces, so research was performed to find a polymer that will bind the particles to a surface while maintaining SH qualities. Test surfaces were prepared by making six solutions of SH powder, a binder, and an alcohol solvent and then dispensing the solution onto plastic and glass slides. Binders tested were polyvinyl butyral resin (PVB), polymethyl methacrylate (PMMA), Rhoplex Fastrack X-tended Seasonal Range resin (XSR), and Araldite resin. Hydrophobicity was tested by measuring the radii of water droplets to calculate contact angles and wettability by recording radii of droplets over time. The surfaces were also observed for scratch resistance, adhesion, and cohesion. Three mixtures showed high angles of approximately 130° to 133°. PVB surfaces had high wettability and poor cohesion, and surfaces made with a higher ratio of binder had poor adhesion. The resin and XSR surfaces maintained some scratch resistance. These tests prove the best surface investigated in this research is made with 0.8 g of SH powder and 0.4 g of XSR. It repels water for an extended time and maintains the highest contact angle at 133°. This surface is not deemed SH because its contact angle is below 150°, but this mixture is most able to remain hydrophobic. The particle mixture forms a consistent film and adheres well to surfaces, but only fair scratch resistance makes it imperfect for potential application. These results are part of ongoing research to determine polymers that bind to particles and withstand environmental conditions experienced in polluted areas.

Implications of Exhaust Stream Sampling Conditions for Measurement of Gas and Particle Emissions from Natural Gas Appliances. *Adam Hall* (*Bowdoin College, Brunswick, ME*)*; Brett Singer* (*Lawrence Berkeley National Laboratory, Berkley, CA*). Accurate measurement of ultra-fine particle and gaseous emissions from natural gas fueled appliances are needed to quantify the potential health and environmental impacts of airborne emissions that may result from use of new gas supplies. In order to quantify differences in emissions between natural gas derived from liquefied natural gas versus conventional gas supplies a variety of used appliances will be accessed and operated. Concentrations of carbon dioxide, oxides of nitrogen, carbon monoxide, oxygen, and ultra-fine particles in the exhaust of these appliances are to be measured. Making such measurements requires that samples of the appliances' exhaust be captured and delivered to a number of gas and particle analysis instruments. This sampling must not interfere with the normal operation of the appliance and must preserve the composition of the exhaust for measurement. Concern has been expressed that in drawing up these emissions the sampling system may change the airflow around

the flame, possibly having effects on the levels of pollutants produced by the burner. Experiments were conducted to assess how the elevation of the exhaust hood relative to the stovetop burner impacts emissions formation. Hood elevation did not affect gaseous emissions appreciably. However, increased hood elevation lead to an increase in particle formation of roughly an order of magnitude. This suggests that even though the exhaust hood does not affect flame performance directly, it does impact characteristics of the exhaust stream, such as temperature, which have a measurable effect on particle formation. This finding illustrates the importance of designing our experimental system to reflect conditions in the consumer setting in all parameters relevant to pollutant formation.

Application of Modern X-ray Techniques to Common Industrial Materials: Measuring the Local Density of Compressed Cellulose Fibers by Ultra Small Angle X-Ray Scattering. *Joshua Hammons* (*Texas Tech University, Lubbock, TX*); *Jan Ilavsky* (*Argonne National Laboratory, Argonne, IL*). Cellulose Fibers have a wide range of applications from simple typing paper to cleaning and personal hygiene products. In many applications the density of the cellulose fibers is very important to ensure the quality of the product. The dimensions of the lamellae fibers are on the order of 1 micron in thickness and several millimeters long. Several other techniques can be employed such as BET analysis and SEM imaging; however, these techniques are very time consuming for large samples and may require cutting of the sample so that individual sections can be evaluated separately. Ultra small angle scattering (USAXS) allows small angle scattering (SAS) data to be obtained from large volumes of samples up to a few cubic mm. A complete 3-dimensional statistical representation of relatively large volumes of samples can be obtained in approximately 20 to 30 minutes for each sample point. Additionally, as many as 100 different USAXS scans can be performed with little to no interaction required by the experimenter at the Advanced Photon Source Beamline 32-ID. The motivation of this research is to evaluate the ability of USAXS to differentiate between varying levels of cellulose density. SAS data obtained from USAXS experiments span up to 4 decades, in Q, of useful data. Therefore, fiber and void sizes, ranging from 1 nm to just over 1 μm can be evaluated. The correlation between the SAS data and density is due to additional hydrogen bonding between fibers, induced by compression, which result in the reduced shared surface area between the cellulose fibers and voids. The reduced surface area is extracted by the Porod constant, obtained from SAS data. All of the data obtained from 52 USAXS experiments indicate that variation in the SAS data can be directly correlated to the density of the cellulose fibers. Some recommendations for future USAXS experiments were also developed. Small angle scattering data obtained from the sample sheets indicated some multiple scattering affects at low Q. For this reason, future USAXS experiments, on similar samples, should be performed at either energies greater than 18 keV or samples thinner than 2 mm. Additionally, the SAS data can be evaluated at much smaller intervals by decreasing the X-ray beam size. In this manner, a complete map of the fluctuation in density can be made for very large industrial samples, comprised of compressed cellulose fibers.

Air Filter Pricing Analysis for a Business to Business or Indefinite Quantity Agreement (Alternative). *Matthew Hardman* (*University of Idaho, Moscow, ID*); *Dale Schielke* (*Pacific Northwest National Laboratory, Richland, WA*). As the number and breadth of the facilities under Pacific Northwest National Laboratory (PNNL) control increase, the need and importance of cost estimates for maintenance of these facilities also increases. As with any business, the cost to maintain operation of its facilities can be a daunting task. The price analysis on air filters for a 'cutting edge' research facility such as PNNL is difficult to achieve since many non-traditional, higher rated filters are needed. In response to the growing difficulty in managing many systems, electronic databases complete with inventories, work orders, preventative maintenance, and purchasing capabilities are being built. One such program which the Facilities and Operations Directorate (F&O) at PNNL uses is MAXIMO, developed by mro software. MAXIMO contains a purchasing capability which can be set up with a business to business (B2B) agreement or indefinite quantity (IDQ) agreement. A B2B agreement is a contract between two businesses for the sale of products directly between the two entities. PNNL wants to set up a B2B or IDQ agreement for air filters as a pilot for using the full capabilities of MAXIMO purchasing capabilities in the future. Using MAXIMO report capabilities, descriptive reports were made for all air filters currently used at PNNL. Microsoft Excel files were then produced and sent out to previous vendors for pricing information. After gathering the pricing information into files, the information was then entered into MAXIMO. These files along with inventories were compared to determine which filters were eligible for excessing. Once the excessing was underway, work on a B2B began. If requirements for a B2B cannot be met, an IDQ will then be set up. This work towards a B2B or IDQ will help create a system in which filters are ordered for "just in time delivery". This kind of system will help with storage costs since not as many air filters will need to be stored on a regular basis. Overall, implementing a B2B or IDQ system will reduce cost and increase the efficiency of the maintenance work, therefore saving money, on mechanical systems here at PNNL.

Thermochemical Ethanol via Indirect Gasification of Lignocellulosic Biomass with Methanol and Dimethyl Ether Intermediates. *Michelle Harris* (*Colorado School of Mines, Golden, CO*); *Steven Phillips* (*National Renewable Energy Laboratory, Golden, CO*). Thermochemical gasification is a process where a carbonaceous feed is partially oxidized to a gas-phase fuel (syngas) consisting mostly of carbon monoxide (CO) and hydrogen (H_2) gases. Syngas can be converted to fuels such as ethanol, methanol, or dimethyl ether (DME) via a catalytic process called synthesis. A 2007 report by S. Phillips, A. Aden, J. Jechura, and D. Dayton at the National Renewable Energy Laboratory (NREL) provided a detailed techno- economic evaluation of a 2,000 tonne wood to ethanol process via gasification and synthesis. The present study evaluates a new scenario that consists of five of these small plants producing methanol or DME from wood, and a larger plant producing ethanol via the methanol or DME collected from the smaller plants. Achieving improved economy of scale for the large ethanol production plant is the reasoning behind this new study. The mass and energy calculations needed for this study were done using the computer simulation program ASPEN®, which models chemical and industrial processes, with the original ASPEN simulation designed by Phillips *et al.* modified to meet the new specifications. The cost of production (COP) of each of the products (methanol, DME, or ethanol) was determined to assess the feasibility of the new scenario versus the original process. The COP was calculated using a Discounted Cash Flow Rate of Return (DCFROR) method programmed in Microsoft® EXCEL. The COP, in units of $/MM Btu and $/gal ethanol equivalent, ranged from $8.73–$10.20/MM BTU and $0.67–$0.78/gal for the methanol and DME scenarios. The methanol to ethanol process used in this study produced ethanol at a COP of $1.26/gal, which is significantly higher than the $1.01/gal from the Phillips *et al.* study. Future research will continue to work on the scenarios involving DME and other process configurations to optimize the industrial plants to achieve their greatest efficiency and to decrease the cost of production.

Alternative Fuels Data Center: Fleet Reports, Databases and Website Redesign. *Brett Hoag* (*University of Colorado, Boulder, CO*); *Johanna Levene* (*National Renewable Energy Laboratory, Golden, CO*). The Alternative Fuels Data Center (AFDC) is online collection of data, including more than 3,000 documents and several interactive tools. The AFDC collaborates with the U.S. Department of Energy's (DOE) Clean Cities Program as well as the Energy Policy Act of 1992 (EPAct) fleet programs. Federal fleet location reports for EPAct were processed using excel, geocoding software and cgi scripts that evaluated the received data to the data located in the AFDC (AFDC) Alternative Fuel Station Locator Database. A total of 15,267 unique fleet locations were processed resulting in an addition of 73,841 vehicles to the AFDC Database. The updating process of the Related Links Database used several different debugging procedures and techniques, as well as work with Oracle database maintenance software. The Clean Cities Success Stories Database update process required extensive work contacting organizations, writing and editing summaries about organizations that are currently implementing alternative fuels within their fleet. During the updating process 131 individual organizations were contacted, resulting in a new Success Stories Database that had 15 new organization summaries as a base. Debugging procedures and techniques were also applied to several online tools available for fleets as well as the public. The Make/Model Application, Flex-Fuel Fleet Vehicle Cost Calculator and the AFDC Laws and Incentives page were debugged for potential problems that new users may experience. The research was conducted to aid in the development of the new AFDC website that has a planned launch date of September 30, 2007.

Updating Tank Information in Current Site Key Plans. *Alexander Hoimes* (*Pennsylvania State University, State College, PA*); *Jason Remien, Peter Pohlot* (*Brookhaven National Laboratory, Upton, NY*). All buildings on the Brookhaven National Laboratory site are represented in drawings known as Key Plans, which are blueprints drawn in AutoCAD. Several years ago a number of upgrades to the infrastructure of the lab were completed, most notably an upgrade to

the aging tank system present at the lab. The tank system consists of chemical, oil, water, and hazardous waste storage. Some of the current key plans have tank layers, and some are missing this layer. A layer refers to specific part of a drawing in AutoCAD that can be shown or hidden by turning the layer on and off. This feature allows one to draw very complex drawings with multiple layers, but at the same time can provide a clear view of the drawing and the specific point of interest when needed. This project corrected the current key plans by updating the tank layer in each plan. A list of updated tanks was available, but the measurements and exact positions must be measured at each site and physically be changed in the Key Plan of each building. So far the updating of the tank layer is on schedule, with a projected completion at the beginning of August. This project is intended to keep the Key Plans up to date, which is essential for the ongoing planning, development, and maintenance of Brookhaven National Laboratory.

Diffractive Optics at Soft X-Ray Wavelengths. *Terence Holloway* (*Norfolk State University, Norfolk, VA*)*; Yanwei Liu, David Atwood* (*Lawrence Berkeley National Laboratory, Berkley, CA*). The Center for X-Ray Optics (CXRO) at Lawrence Berkeley National Laboratory works to advance the science and technology of short-wave optical systems through applications using extreme ultraviolet light (EUV) and Soft X-Ray wavelengths that range from 1 nm–50 nm. The short wavelength radiation is generated by a machine known as a synchrotron. The synchrotron used in our experiment, operated by Lawrence Berkeley National Laboratory, is the Advance Light Source (ALS). At these wavelengths there are a large number of atomic resonances which cause the absorption of radiation over short distances (in nanometers or micrometers) in most materials. As a result, conventional devices which operate in the optical region of the electromagnetic spectrum are no longer applicable at these short wavelengths. CXRO specializes in two classes of optics that operate at EUV/Soft X-ray wavelengths, reflective multilayer coatings and diffractive optics. This SULI research project places emphasis on nanometer scale diffractive optics. It begins by creating programs for the optical devices using Matlab. A Graphical User Interface (GUI) was created to generate desired patterns for the optics chosen by the user. The GUI runs a simulation of diffractive soft X-ray optics based on electromagnetic wave propagation. The simulation will give us a good idea of how the experiments performed in the ALS will result. After running the simulation, we performed actual synchrotron experiments using those specialized optics at ALS beamline 12.0.2.

Modeling of an Aerosol Collection Inlet for Interior Monitoring. *Robert Igel* (*Bradley University, Peoria, IL*)*; David Decroix* (*Los Alamos National Laboratory, Los Alamos, NM*). The dispersion of biological agents into populated environments is a serious terrorist threat faced by the United States. Possible targets of biological terrorism include densely populated areas such as stadiums and public transportation systems. Los Alamos National Laboratory wants to be able to collect air samples in these areas using an aerosol inlet for a collection device that has been designed to be installed in the HVAC system of densely-populated buildings. The inlet was designed to collect particles less than 10 µm. Preliminary testing has been performed on this design; however, a more complete understanding of the inlet was desired. The purpose of this research was to model the same inlet using the Fluent computational fluid dynamics solver to provide more conclusive collection efficiency results and determine the flow characteristics caused by the inlet. The 3-D model of the design, its mesh, and its boundary conditions were constructed in Gambit. This file was then exported into the Fluent solver, where flow conditions — turbulence, flow rate, and particulate size — were specified. Several wind tunnel tests were run varying the free stream velocity between 2 and 8 km/hr and particulate sizes of 8, 12, and 20 µm. The results of these experiments show that the inlet will collect the vast majority of the 8-µm particles, only a small percentage of the 12-µm particles, and none of the 20-µm particles. However to determine the streamlines and other flow properties of the inlet geometry and its overall efficiency, computational simulations have been run. The results from this research will better enable the detection of biological agents harmful to building occupants.

Improving the Documentation of Findings and Corrections. *Philip Irminger* (*Pellissippi State Technical Community College, Knoxville, TN*); *John Czachowski* (*Oak Ridge National Laboratory, Oak Ridge, TN*). Currently at ORNL, there is a program in place known as the Operational Awareness Program (OAP). This program is designed to help ensure that regulations are being followed in the various laboratory spaces, and that proper safety measures are being addressed to help protect all those involved. The OAP team has members consisting of Subject Matter Experts (SME), and also DOE representatives. Using a variety of SME's allows for a vast variety of knowledge of the various hazards which may be present including chemical, electrical, and environmental. During the OAP inspection, findings are found and documented including violations, possible hazards, and also noteworthy practices. In the past, documenting these findings has been documented via confirmation in writing; however I have been tasked with assisting in documentation of these findings via photographs. I will assemble pictures of the findings both before and after corrective actions have taken place. Through assembling these photographs the corrective actions that have taken place will be relayed to the OAP team to document resolution of the findings. By following this procedure, there is no doubt about the corrective actions that have been completed. It also allows for reference photographs for similar issues in other sections of the laboratory. Through the use of this documentation of the OAP assessments, there will be a reliable and effective way of documenting the corrective actions which have taken place to resolve any issues found during the inspection.

Transmission IR Microscopy of CdZnTe Crystals for Nuclear Radiation Detectors. *Jesse James* (*Tennessee Technological University, Cookeville, TN*)*; Aleksey Bolotnikov* (*Brookhaven National Laboratory, Upton, NY*). The key problem of CdZnTe (CZT) crystals is trying to find a correlation between defects or inclusions found in the layers within the crystal itself and, trying to prove that inclusions affect the responsiveness of CZT detectors. Along with other projects investigating CZT defects using highly collimated X-ray beams and the spectral response of CZT detectors, this research seeks to discover an optimal and efficient way of analyzing the uniformity of CZT crystals. Using a highly sensitive camera taking infrared beams of the given CZT detector and correct amount of light exposure, five points of position on the crystal (10mm x 5mm x 5mm crystals dimensions) were taken. Using the Interactive Data Language (IDL) program was created to identify the defects accurately and precisely to have sufficient data for the examination of results. The results are correlated to the full width half maximum (FWHM) at 1,000V bias and to the concentration threshold of inclusions that was >20 µm in diameter. Approximately half of the detectors that were tested have had moderate to good quality detector response. However, their has been many defects in the crystals such as twins, dislocations, grain-boundaries, precipitates, and >20 µm inclusions. The structural non-uniformity of CdZnTe crystals around Te Inclusion is responsible for electron transport non-uniformity and diminished energy resolution of large-volume CdZnTe coplanar-grid detectors. This work is expected to be completed at the end of 2007 in making CZT detectors more robust and less expensive compared with other detectors.

Scheduling. *Darren Johnson* (*Brigham Young University – Idaho, Rexburg, ID*); *Rick Staten* (*Idaho National Laboratory, Idaho Falls, ID*). I was tasked to perform data entry work on Excel spreadsheets and Primavera Project Manager Gant Charts. I worked on several projects, most of which pertained to the testing of new fuels. My tasks were to create logical connections between series of activities. These activities were individual steps within a project and when tied together they create a logical sequential order that can be followed in order to finish a project correctly and on time. The projects I have been working on are both on-going and future projects that may not be started yet. This is a continuum report that will be on-going after I leave Idaho National Laboratory.

Ultrasonic Evaluation of Bolt Elongation. *Kyle Johnson* (*Washington State University, Pullman, WA*); *Morris Good* (*Pacific Northwest National Laboratory, Richland, WA*). The automotive industry has an interest to improve measurement consistency of clamp load when using threaded fasteners. Several early studies were done in support of this effort to acquire ultrasonic elongation measurements to estimate bolt clamp load for an automotive application. The first study correlated bolt elongation with measurements obtained with a 7 MHz transducer bonded to the bolt head. The second study placed unfocused immersion transducers with varying frequency and diameter above the bolt head and empirically evaluated the pulse-echo signal from the other end of the bolt as a function of these parameters. A third study looked at a limited variety of coupling materials. Data showed that bolt elongation correlated well with the change of the ultrasonic time-of-flight for the case that the transducer was bonded to the bolt head, that selection of frequency and transducer diameter affected the signal to noise ratio, and that membranes used in combination with an applied force were capable of coupling ultrasound between a transducer and a bolt head. Future research should continue the examination of coupling materials and use this information to examine measurement stability during the tightening process. This document contains Battelle-Business Sensitive

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Gas retention and release in the presence of an Anti-Foaming Agent during the nuclear Waste Treatment Process. *Wesley Johnson* (*Bevill State Community College, Fayette, AL*); *Consuelo Guzman-Leong* (*Pacific Northwest National Laboratory, Richland, WA*). Nuclear waste stored at the Hanford site in Richland, Washington, will be vitrified in order to dispose of the waste in an environmentally sound manner. Hydrogen gas generated by radiolysis within waste processing tanks in the Waste Treatment Plant (WTP) could combust under some upset conditions, posing a significant safety concern. The Anti-Foaming Agent (AFA) research team utilized a Quarter Scale Lag Storage system to facilitate gas hold-up and release testing in simulated waste materials mixed using a hybrid system comprised of pulse jet-mixers (PJMs) and spargers. We utilized PJMs and spargers because they are the most effective method of mixing, requiring the least amount of maintenance. Mixing the waste creates larger bubbles than the bubbles from the waste itself and these larger bubbles, in connection with the actual mixing, allow for the release of the gases at the surface of the waste. This waste is an assortment of varying by-products exhibiting non-Newtonian rheology which determines how and when gases will be released. Data collected will address potential hazards during pretreatment processes by determining whether or not a significant portion of potentially flammable gases will be released during the mixing phase and whether or not an alternative AFA must be utilized in order to minimize gas retention. My team administered a series of tests to collect data for extrapolation to full scale operations. One series consists of water visualization tests with and without AFA, another of clay, a third of simulant with and without AFA, a fourth of simulant using research-determined, bounding yield stress for gas retention or ~13 Pa. — depending on which of the two is lower — with AFA or an alternative AFA, and a final series of simulant with an alternative AFA. Varying yield stresses of ~ 3, 13, and 30 Pa. were used in the clay and simulant testing series because previous research suggested that the AFA impact upon gas retention differed depending on the yield stress of the simulant. Our team employed hydrogen peroxide as the most effective method of generating gas bubbles for testing without introducing significant error to the research. Results are not available because testing is in progress. Our team's information will be used to determine appropriately safe working conditions as they pertain to gases escaping during the waste treatment and if a different type of AFA is necessary to also reduce dangers.

Green Processes: Synthesis of Higher Oxygenates Using Transition Metal Catalysts in Aqueous Phase. *Sheena Joseph* (*State University of New York at Stony Brook, Stony Brook, NY*); *Devinder Mahajan* (*Brookhaven National Laboratory, Upton, NY*). Biomass can be converted to useful fuels and chemicals by two methods: biological and thermochemical. Certain microorganisms that process simple sugars as a carbon source mediate the biological route, seen in the well-established fermentation pathway to ethanol. The thermochemical route is a two-step process that involves biomass gasification to yield synthesis gas (or syngas), a mixture of carbon monoxide and hydrogen and catalytic conversion of syngas into higher oxygenates. This pathway requires development of highly efficient catalysts to achieve total carbon utility and produce biofuels economically. Since methanol can be produced selectively and in high yield by catalyzed reaction of syngas at low temperatures, catalysts that efficiently convert methanol into C2+ oxygenates are being investigated. A supported Rh catalyst, Rhodium on alumina, was evaluated at 200°C for activity because Rh-based catalysts are known to promote methanol homologation (carbon-carbon coupling) into ethanol at 200°C. However, in the present work, Rh on alumina was observed to yield dimethyl ether at 200°C. A ruthenium catalyst operating in an aqueous phase under moderate conditions was also evaluated. The reactions were conducted in a 300 mL Parr batch reactor fitted with gas and liquid sampling ports. The fate of the catalysts was monitored *in situ* using gas chromatography and infrared spectroscopy. The ruthenium catalyst, $Ru_3(CO)_{12}$, was also observed to yield dimethyl ether at 200°C. Dimethyl ether is currently considered an attractive replacement for diesel fuel. More work is underway to further study these systems for biomass to fuels conversion.

A New Routing Protocol for Connectivity in *Ad Hoc* Networks. *Tyler Karrels* (*University of Wisconsin – Madison, Madison, WI*); *Sami Ayyorgun* (*Los Alamos National Laboratory, Los Alamos, NM*). TCP/IP routing is the standard for static wired networks, but TCP/IP cannot quickly adjust to changes in network topology that can occur in wireless *ad hoc* networks. A wireless *ad hoc* network's topology is dynamic because hosts eventually lose power, hosts' transmission ranges may vary over time, hosts may become damaged, or hosts may enter or exit the network's transmission range. These problems require new routing paths to be established to maintain network connectivity. The purpose of our research at Los Alamos National Laboratory (LANL) is to improve, or at least maintain, connectivity between hosts even when the network topology is drastically altered. We propose a new routing protocol called Neighbor Monitoring (NM) that creates multiple paths to the network sink and monitors these paths to decide which is optimal. Network simulations have been conducted in Matlab using a simulator developed for this research. For a comparison to existing routing algorithms, Dynamic Source (DSR) and Load Balance (LB) routing algorithms have been implemented in addition to NM routing. Simulations are being run with networks of varying size and topology. The three topologies used are grid, random, and degree based. Preliminary results for small networks have shown that DSR and LB algorithms perform better than NM in a grid network topology and no node failures. It is expected that NM routing will be more resilient by quickly repairing routes. It is also expected that NM routing will establish quicker routes even when a network is heavily loaded.

Dirty Bomb Simulation Experiment: Usability, Control Condition Selection, and Composite Mission Performance. *Tim Klein* (*Oregon State University, Corvallis, OR*); *David Bruemmer* (*Idaho National Laboratory, Idaho Falls, ID*). To further the understanding and evaluation of the problems of usability, control condition selection, and composite mission success related to human robot interaction in high stress conditions, a dirty bomb experiment and simulation field study was conducted in an as-near-as-possible real world situation. This paper focuses on the simulation portion of the study with emphasis on the theory that the robot performing under semi autonomous control conditions will show improved holistic performance when compared to manual control conditions. The simulation utilized the current control conditions and interface methods available to the robot system. In the simulation, the participants were asked to find three simulated radioactive sources using the two control conditions, the Shared control using a joystick providing continuous operator control or the newer semi-autonomous Target control. Both control conditions use the robot intelligence kernel (RIK) developed by the Robotic and Human Systems Group at the Idaho National Laboratory for optimized mission success along with environment and robot system safety protection. The data collection came from three different techniques, logged communications from the RIK, participant self evaluation questionnaires, and administrator observations. The greatest differences found during data analysis appear in the participant evaluation characteristics of input and workload demands and the perceptions of control and understanding, shown by comparison and statistical tests of the control conditions. The results show that with an approximate difference of 92 seconds there is no statistically significant difference between the control conditions with respect to the average time taken to complete the task. The results of the holistic composite performance equation, represented by the non control condition specific performance characteristics, favor the Target control condition in which the participants felt less demand and had a higher feeling of mission performance and control. As a design tool, the simulation provides a useful adjunct to field studies and provides insightful evidence, if not entirely conclusive, to continue the development of the Target control condition for use in urban search and rescue, situations involving object detection, and in reducing human exposure during environmentally hazardous missions.

Conceptual Design of a New Large Scale Wind Turbine Drive Train Testing Facility. *Scott Lambert* (*University of Colorado, Boulder, CO*); *Jason Cotrell* (*National Renewable Energy Laboratory, Golden, CO*). Laboratory testing of wind turbine drive trains is an important way to validate designs, test reliability, debug systems, and verify computer and analytical models. The large physical size and high torque requirements of modern wind turbines present engineers with unique manufacturing and testing challenges. The 2.5 MW drive train testing facility at the National Renewable Energy Laboratories (NREL) in Colorado is one of a few facilities capable of testing multi-megawatt wind turbine drive trains. The rapid growth of wind turbine size has outpaced the facility's capacity to test very large wind turbine systems. The goal of the research described in this report is to identify possible configurations, assess the technical challenges, and investigate the

costs for a new, larger, 12 MW drivetrain test facility. The identification of potential dynamometer configurations was conducted by examining large test facilities in use overseas, and through consultation with industry. Several conceptual designs were modeled using computer aided design software and a preliminary engineering analysis for each concept was conducted. Readily-available components that could be used in this project and suppliers capable of assisting with engineering and manufacturing of limited production components were identified. The concepts where then judged against each other on the basis of cost, component availability, and relative ease of implementation. This research shows that configurations using large custom built gearboxes and motors are expensive and require long lead times due to technical obstacles in engineering and manufacturing. Concepts using large custom components show higher overall system costs than those using multiples of smaller, more readily-available components that distribute the high torque loads over several load paths. While initial estimates show that these distributed-load systems have considerable potential for cost savings, further investigation into these concepts is required to assess the risks involved. Furthermore, the results of this study indicate that concepts such as single motor and gearbox combinations suitable for use in smaller scale test bench systems do not scale well up to 12 MW, and do not offer the same setup and configuration flexibility that is possible with distributed load concepts.

***Simulation of Shearing in Dense Granular Flows.** *Brian Langstraat* (*Central College, Pella, IA*)*; Shankar Subramaniam* (*Ames Laboratory, Ames, IA*). Understanding the response of granular matter to mechanical loading is essential to many applications in science and engineering, such as avalanches and hopper flows. The constitutive behavior of pure solids or fluids is well understood by researchers. However, the mechanical response of granular matter, which can exhibit fluid-like or solid-like behavior depending on the loading conditions and volume fraction, is not well understood. In this work, computer simulations of interactions between individual particles that constitute the granular matter are used to test continuum models of granular flow. We use the Large-scale Atomic/Molecular Massively Parallel Simulator (LAMMPS) which was developed at Sandia National Laboratories to simulate the dynamics of a large number of particles. The response of granular matter to plane shear between two parallel plates is chosen as a canonical test problem. The LAMMPS simulation data is analyzed to understand the evolution and steady-state profiles of volume fraction, average velocity, granular temperature, and stress. Glass beads are simulated with a volume fraction of 0.46. Three shear rates are tested corresponding to the slow frictional, transitional, and intermediate regimes. The sheared particles tend to form striated layers in planes parallel to the shearing surfaces. The simulations reveal that the center layers are very dense with high stress and a linear change in velocity. Also, the granular temperature is low within the center layers. We conclude that in the dense, central layers of the sheared granular flow there are less velocity fluctuations. This research is part of a larger project that will help to further the understanding of dense granular flows.

Wireless Roadside Inspection Proof-of-Concept Test. *Mary Lascurain* (*Pensacola Christian College, Pensacola, FL*)*; Gary Capps* (*Oak Ridge National Laboratory, Oak Ridge, TN*). Safety inspections are performed on commercial vehicles to promote safety on the roadways, but these inspections are limited due to their labor-intensive nature. The use of a wireless inspection method could dramatically increase the number of safety inspections by allowing enforcement personnel to check driver licensing, medical card, carrier, and weight information without requiring the driver to stop. This proof-of-concept test examines the feasibility, effectiveness, and limitations of the wireless inspection method. PeopleNet, a producer of current electronic on-board recorder technology, designed a system to produce a Safety Data Message Set (SDMS) containing the desired information. This SDMS data was compared to similar data obtained through an independent monitoring system comprised of an eDAQ-lite, VBOX III, Air-Weigh, and custom software. The ability to send and receive an SDMS at varying truck orientations (in 45-degree increments), distances (100 ft to 400 ft), and frequencies (5.9 GHz and 2.4 GHz) was tested under static conditions. SDMS transmission from the instrumented truck to a roadside unit and mobile enforcement vehicle (MEV) was tested at various relative speeds in the dynamic portion of testing. Tests were performed at 2.4 GHz as well as 5.9 GHz, and two different antenna types (dome and stick) were used. Most of the test data for the SDMS files was accurate. However, due to software problems in the PeopleNet system, over an hour was required for some driver status changes to be reflected in the SDMS. The best reception under static conditions was found to be to either side, slightly ahead of the instrumented truck. Reception was best on the right side, where the antenna was located. The dynamic tests indicated that the dome-type antenna had better reception at 2.4 GHz, while the stick antenna performed better at 5.9 GHz. The use of a tripod for the antenna mount increased the reception for both antennas. Files were successfully transferred at various speeds (up to 55 mph). This proof-of-concept test demonstrated the feasibility of a wireless inspection method while identifying areas in which further testing would be beneficial. Further research should include more extensive testing to determine ideal antenna height, the most appropriate frequency, and the optimum mounting locations for both trucks and MEVs. Additionally, the effects of terrain, other vehicle interference, and weather will need to be well understood.

Polyhydroxyl Fullerene with Silicotungstic Acid Hydrate to Create a Composite and Integrate With Nafion® Polymer to Create a Proton Exchange Membrane. *Joshua Lau* (*Colorado School of Mines, Golden, CO*)*; John A. Turner* (*National Renewable Energy Laboratory, Golden, CO*). The U.S. Department of Energy's (DOE) goal is to have a membrane for the PEM that will operate at 120–150°C and a relative humidity (RH) of 25% or less by the year 2010. Proton exchange membranes (PEMs) for fuel cell applications have current limitations on the materials and capabilities of the membrane as is. There has been research to modify the perfluorosulfonic acid (PFSA) polymer based membranes, most notably, Nafion®, by doping PFSA membranes with different compounds, such as heteropoly acids (HPAs), to increase the conductivity of the membranes, and with other particles to improve the longevity of the membranes at high temperatures and low relative humidity. In this research, a combination of polyhydroxyl fullerene (PHF), a fullerene derivative, and silicotungstic acid hydrate (HSiW), were combined in two separate solutions and mole ratios of one-to-one and one-to-four, respectively, to create a composite. Infrared spectroscopy (IR) was conducted on the composite at various stages of the process. The results showed that the resulting compound differed from the starting material. An *in-situ* method of mixing of the two compounds on a stir plate in mole equivalent ratios of one-to-one, one-to-two, one-to-three, and one-to-four in the DuPont DE2820 polymer matrix was done in order to make membranes. Three controls were also cast at the same time to get base conductivities for comparison. The conductivities of the *in-situ* mixed membranes of the controls were found to have conductivity values of 132 ± 15 $mS \cdot cm^{-1}$, 23.4 ± 0.2 $mS \cdot cm^{-1}$, and 156 ± 15 $mS \cdot cm^{-1}$ for PHF; 129 ± 18 $mS \cdot cm^{-1}$, 21.5 ± 3.0 $mS \cdot cm^{-1}$, and 150 ± 21 $mS \cdot cm^{-1}$ for HSiW; and 130 ± 8 $mS \cdot cm^{-1}$, 24.2 ± 4.4 $mS \cdot cm^{-1}$, and 162 ± 2 $mS \cdot cm^{-1}$ for DuPont DE2820. The mole ratio conductivities had average values 146 ± 20 $mS \cdot cm^{-1}$, 26.6 ± 22 $mS \cdot cm^{-1}$, and 194 ± 20 $mS \cdot cm^{-1}$. All of the values were at 60°C 100%RH, 80°C 50%RH, and 80°C 100%RH, respectively. The values are promising compared to Nafion® which is well known and reported. It is also interesting that added separately, the materials actually had worse conductivity than that of the pure DuPont DE2820, but when the materials were combined, the conductivity was greater in all cases.

An Ergonomics Guide to Pipette Selection and Use. *Monica Lichty* (*University of Michigan, Ann Arbor, MI*)*; Ira Janowitz* (*Lawrence Berkeley National Laboratory, Berkley, CA*). The ergonomics of laboratory environments has not been developed as thoroughly as that of computer workstations and there is not much current guidance on ergonomics attributes of common laboratory equipment for the scientific community. This means that scientists and technicians are in great danger of developing upper extremity cumulative trauma disorders (CTDs) such as tendonitis and carpal tunnel syndrome from their regular activities. The focus of this project was on providing a usable guide to pipette and pipet controller selection for the employees at the Lawrence Berkeley National Laboratory (LBNL) to facilitate purchasing decisions and reduce the rate and severity of injuries associated with manual pipetting. The first step in the development was to become familiar with the pipette models that are commercially available. Interviews were conducted to learn which qualities of a pipette are important to users. Insight was also gained into the ways in which pipettes are held and operated through observation. Once a final list of attributes was determined, meetings were held with pipette manufacturer representatives to obtain demonstration products for assessment and to learn about the different product lines. The main quantitative measurements were: weight, plunger force, tip ejection force, blowout force, maximum thumb displacement, girth, and overall length from the thumb support to the end of the tip ejector sleeve. Other qualities were recorded such as autoclavability, electronic program options, and charging method of the pipettes. A section of comments was developed based on user input and ergonomics

factors including handle comfort, display legibility, and ease of volume adjustment. The guide will be available in two versions. The quick reference guide is comprised of product ratings in a variety of categories including weight/balance, grip comfort, and control forces. The extended user guide includes all of the quantitative information obtained as well as free-form comments about the products. Both versions of the guide will be available online to all employees of LBNL. The guides also come with a set of tips on posture, workstation layout, and task design to address the task as a system of interacting factors rather than solely a tool design issue. Although the guides provide an increased level of assistance to consumers, they will only remain relevant if they are updated on a regular basis to include new products and improvements.

Development of a Vacuum Monte Carlo Code. *Reynaldo Lopez* (*University of California – Los Angeles, Los Angeles, CA*)*; Matthaeus Leitner* (*Lawrence Berkeley National Laboratory, Berkley, CA*). This paper presents the initial development of a three-dimensional Monte Carlo computer code that calculates the vacuum pressure of a sample cylindrical pipe vacuum vessel. The implementation of a basic Monte Carlo molecule-tracing algorithm is discussed. The pressure distribution is determined by tracing particles through the vessel structure; converting the trajectory lengths to molecular residency time by using the average molecular velocity. Simulations with various molecule sample sizes are implemented and compared to conventional analytical vacuum formulas. First code results calculate a correct parabolic pressure profile. Future work will include the development of a new geometry module for 3D CAD data, and the implementation of different surface conditions.

Studies of Cadmium Zinc Telluride (CZT) Defects with Highly Collimated X-ray Beams. *Alexander Luryi* (*Cornell University, Ithaca, NY*)*; Aleksey Bolotnikov* (*Brookhaven National Laboratory, Upton, NY*). Cadmium Zinc Telluride (CZT), an alloy of cadmium telluride and zinc telluride, is a wide bandgap semiconductor which has shown great potential in gamma radiation detection. While detectors that use other materials, such as germanium, must be cooled with liquid nitrogen to function usefully, CZT detectors have the distinct advantage of being able to operate at room temperature. In addition, since the creation of electron-hole pairs in CZT requires very little energy, CZT detectors take far less power to operate. However, it is hypothesized that the presence of tellurium (Te) inclusions in CZT crystals inhibits detector performance. The purpose of this work was to correlate the presence of these inclusions with decreased CZT detector quality. This was accomplished in three steps: first, crystals were scanned using infrared microscopy. Since CZT is transparent to infrared light, inclusions were easily visible in an infrared light source. Next, detectors were built out of these scanned crystals and their spectral responses were measured in the presence of a Cesium-137 source. Finally, the crystals were tested with a collimated X-ray beam to determine the significance of the defocusing effect, in which a nonuniform electric field causes charge to curve outward to the surfaces of the crystal. Comparisons between infrared imaging and pulse-height spectra showed a weak but implicative direct correlation between Te inclusion density and the absorption peak's full-width half maximum. The X-ray analyses provide further insight into each crystal's response by producing a pulse-height spectrum for a multitude of small areas of the crystal surface. This experiment demonstrated a phenomenon in which a crystal's response is best at its longitudinal center and decreases dramatically around its edges. The department of homeland security has expressed interest in CZT development and these results may foster significant advances in radiation detection.

Vehicle Immobilization Technology Evaluation Project. *Joseph Massimini* (*Purdue University, West Lafayette, IN*); *Gary Capps* (*Oak Ridge National Laboratory, Oak Ridge, TN*). Since September 11, 2001, the Federal Motor Carrier Safety Administration (FMCSA) has been actively investigating methods to improve safety, security, and efficiency through the Hazardous Materials Safety and Security Technology Operational Test. The purpose of that Operational Test was to quantify the security costs and benefits of an operational concept that applies technology and improved enforcement procedures to hazardous materials (hazmat) transportation. In 2005, the House of Representatives Conference Report 108-792 stated that further testing of technologies, including vehicle immobilization is necessary. The present Vehicle Immobilization Technology (VIT) Evaluation Project has been conducted to support the Congressional directive, and has built on the experience and lessons learned from previous field operational tests. A VIT is any technology that prevents a highway vehicle from reaching its destination. There are two types of VITs. Vehicle Disabling Technologies (VDTs) prevent the motion of a stopped vehicle, and Vehicle Shutdown Technologies (VSTs) stop a moving vehicle. These devices typically work through communication between a dispatch office and the vehicle's on-board computer system, and use GPS and/or cellular technology. The VIT evaluation project used information from the FMCSA Operational Test to compile a list of vendors of VIT technologies. As available, companies provided ORNL public information that they had about their products for review. Visits were conducted to selected companies in the United States. In February 2007, six companies demonstrated their products to ORNL and members of the federal government at Michelin North America's Laurens Proving Grounds near Laurens, South Carolina. A test track was used to allow moving vehicles to be shutdown safely in a secured area. Test vehicles were outfitted with sensors to collect kinematics data for evaluation. In March 2007, a workshop was held at the annual Commercial Vehicle Safety Alliance (CVSA) conference in Atlanta, Georgia where the use of VITs was discussed, and an open forum elicited input from attendees. Information collected from these events were used to create a report that contained best practices for hazmat carrier utilization and a concept of operation for law enforcement so that the safety and efficiency of VIT usage can be emphasized. The final report will be sent to Congress for their review and further consideration.

Development of the New AutoCAD Layering Standard. *Thomas McMillin* (*Columbia Basin College, Pasco, WA*); *Shauna Anderson* (*Pacific Northwest National Laboratory, Richland, WA*). The Engineering and Design Services group of the Facilities and Operations directorate at the Pacific Northwest National Laboratory design and draft their projects on the AutoCAD program that is put out by Autodesk. The need for a standard layering system is critical to stay organized and consistent. Layers are used in AutoCAD to differentiate between types of objects. Most of the drawings that are drafted contain different disciplines in them such as, architectural and electrical. There is a National CAD Standard already developed; however there is an over-abundance of layers that fall outside the scope of what would be used. It was decided to use a modified version of the general layout of the national standard. The research team investigated all of the disciplines that are used at Pacific Northwest National Laboratory. Then layer names were developed in a matrix, using the Microsoft Excel program. After verifying the new matrix, the layer names were transferred into the AutoCAD program. Line types, line weights, and colors were added to the layers. Layers were organized by discipline and systems to be incorporated into drawings as they are needed. After the addition of 744 layers into the program, the comprehensive layering standard was unparallel to any of the standards that were in place. There will now be very little that is drawn which does not have a layer assigned to it. If there is something drawn that does not fit one of the other layer categories, a miscellaneous layer exists. As a living document, the AutoCAD layering scheme can be reviewed and revised when needed. This project not only provides a greater understanding of what goes into an official drawing, it lays a foundation for consistent drawings within the Engineering and Design Services group for many years to come.

Analysis of Interstate Weigh Station Viewer Performance. *Ramon Colon Mendoza* (*Florida International University, Miami, FL*)*; David E. Hill* (*Oak Ridge National Laboratory, Oak Ridge, TN*). After the 9-11 attacks, the United States has increased its focus on developing technologies designed to warn us in the event of another attack, and to prevent these attacks from happening. The Sensor Net research group at ORNL is participating in this effort by developing systems to give critical real-time information to federal, state, and local emergency response decision makers. Sensor Net's Southeastern Transportation Corridor Pilot (SETCP) Project utilizes interstate weigh stations not only to weigh the passing trucks but also to check for Gamma and Neutron radiation inside the truck without the aid of a human in close proximity. My role is to characterize and analyze the data from the South Carolina weigh station on I-26W and the Tennessee weigh station on I-40 E. The purpose is to find patterns in the truck traffic as well as to find patterns of inconsistency that the system makes repeatedly. Also I analyze the improvement after the repairs. Inconsistence patterns are found by analyzing the data, looking for missing information, and how often it happens. Traffic Patterns are found by grouping all the data and making graphs and charts that show the flow of the traffic, the kind of truck traffic, the number of alarms, as well as other information. It has been found that Monday, Tuesday, Wednesday, and Thursday the truck traffic is heaviest. Both the component to determine truck length and the component to read each truck's license plate were inaccurate, but have now been fixed as a result of my data analysis.

Dense Ceramic Membranes for Hydrogen Production. *Stephen Menke* (*University of Illinois at Urbana-Champaign, Urbana, IL*)*; U. Balachandran* (*Argonne National Laboratory, Argonne, IL*). It is known that the ceramic compound $SrFeCo_{0.5}O_x$ (SFC2) can be used as an oxygen transport membrane (OTM) to produce hydrogen through water dissociation. The primary challenge for this project was the development of OTMs that transport oxygen at an industrially significant rate. Several factors affect oxygen flux through a membrane including membrane thickness, temperature, and water partial pressure (pH_2O). Previous studies with thick membranes (1.76 ~ 0.21 mm) show that oxygen flux through the membrane increases as membrane thickness decreases. To try and further increase oxygen flux, SFC2 membranes of thickness 20 ~ 30 μm were made. Porous layers made of SFC2 were added on both sides of the membrane to maximize surface reaction kinetics. Membranes were sealed in a reactor assembly to conduct pH_2O dependence measurements as well as compare thickness dependence measurements. A hydrogen production rate of 6.5 $cm^3/min\text{-}cm^2$ was obtained with a thin film membrane at 900°C, 49 vol% H_2O/N_2//80% H_2/He. The hydrogen production rates obtained were similar to previous measurements conducted on a 0.21 mm disk without porous layers. SEM characterization was then performed and indicated differences in the dense layer microstructure when sintered in hydrogen vs. air. Further work should be allotted to better understanding the microstructure of SFC2 as its composition plays an important role in determining the hydrogen production rate.

Analysis of Renewable Energy Deployment in Colorado by 2030. *Russell Muren* (*University of California at Berkeley, Berkeley, CA*)*; Chuck Kutscher* (*National Renewable Energy Laboratory, Golden, CO*). Currently most utilities in the state of Colorado are subject to the 20% renewable portfolio standard (RPS) passed by voters in 2004 and expanded by the state legislature in 2007. However, because of bonuses and exemptions written into the law, the true required renewable energy penetration is only 12.3%. This makes this law less then adequate for addressing climate change. This study aims to assess the real renewable energy and carbon impacts of the current RPS and investigates the benefits of increasing the RPS to true 20% and 30% values. To this end a user input-driven predictive Excel model was developed to find the proper technology spread, electrical outputs, and carbon reduction for each RPS. It was found that while all the RPS variants are technically feasible based on available renewable resources, only the 30% RPS meets the carbon reductions that are thought necessary to avoid the worst impacts of climate change. Based on the results of this report the current RPS does not offer an effective avenue to reduce fossil fuel and carbon reduction. Furthermore, if the goal of the current Colorado legislature and administration is carbon reduction, a 30% RPS is the most acceptable avenue.

Reactants Flow Field Design Optimization For Hydrogen and Direct Methanol Fuel Cells. *Glenn Musano* (*Farmingdale State College, Farmingdale, NY*)*; Devinder Mahajan* (*Brookhaven National Laboratory, Upton, NY*). Fuel cells are considered to be a clean and reliable power source, converting hydrogen to electricity and water by means of a catalyst. The channels' pattern that the reactants flow through, contribute to the overall efficiency of the fuel cell. Graphite fuel cell bipolar plates using the standard flow pattern was considered a reference of comparison for two alternate patterns that operated at 30°C.The alternate flow patterns are newly designed to conserve humidity within the cell, help humidify the cell membrane and maintain efficient power output. Each experimental cell was tested with hydrogen and methanol to determine the pattern with the optimal performance for each fuel. These alternate flow patterns have demonstrated a 20% increase in maximum power output. The pattern with the highest power density will be utilized to build a fourth cell using thermal sprayed aluminum bipolar plates to examine the effect of metallic plates on the cell performance. Thermal sprayed aluminum bipolar plates have been compared to graphite in an earlier work and determined to be more efficient. The success of the new flow pattern will be determined by incorporating it in the future design of a one kW fuel cell system and comparing the output power density of this new metallic fuel cell to the commercially available systems operating with the old flow pattern.

***High-Throughput Protein Crystallography.** *Tuyet Nguyen* (*Contra Costa College, San Pablo, CA*)*; Minmin Yu* (*Lawrence Berkeley National Laboratory, Berkley, CA*). Proteins are the building blocks of living cells and control much of the biochemical processes that are important to all life. Different kinds of protein play different roles in the body. Because structure of proteins is essential to understand the natural function of cells, our goal is to identify the structures of the full complement of proteins, using X-ray crystallography. Using the computer system, the diffracted patterns of the protein crystal can be translated into a 3-D structure. The research group focuses mainly in producing protein crystals. Before setting plates to crystallize protein, the first step was to do cloning and purifying protein if necessary. In the process of protein purification, cells were added to lyses buffer sonicated to break the cells. The supernatant, which contained protein of interest, would be obtained after centrifuging the lysate. Later, the supernatant was run through Ni-NTA Chromatography to purify the protein and was done further purification using gel filtration column. After we got purified protein, a crystallization process was obtained using vapor diffusive method with sitting drop. Series of protein solutions were set up in droplet in a 96-well plate and let to crystallize for a certain time. During the time that protein was crystallizing, a close follow up viewing plate was taking place. Then the crystallization condition and crystal viewing results were entered into CLIMS database. We tried to find possible crystallization conditions from initial crystal hits. The initial hits of crystal formation leads to further optimization for obtaining high quality crystal that can give the best result in diffraction. The selective protein crystals were harvested and tested on the synchrotron beam line. Minmin Yu directly did the X-ray crystallography process. The crystals were mostly analyzed with the synchrotron at the Advance Light Source (ALS) of Lawrence Berkeley National Laboratory. Various proteins that are analyzed at this lab are for the Integrated Center Structure and Function Innovation, and TB Structural Genomic Consortium.

Forced Convection Heat Transfer in Cooling Channels Enhanced with Copper Wire-Coil Inserts. *William O'Brien* (*University of Rhode Island, Kingston, RI*)*; Jeff Collins* (*Argonne National Laboratory, Argonne, IL*). Front end high-heat-load components of the insertion devices and bending magnets at the Advanced Photon Source are cooled with deionized (DI) water flowing through channels which have oxygen free copper (OFC) wire-coils inserted into them, enhancing the forced convection heat transfer. The convective heat transfer coefficient within these cooling channels is studied to optimize operational parameters. Data collected is reduced to several empirical relationships and prepared for publication to an international heat and mass transfer audience. Several OFC heat transfer test tubes are used, each with a 0.375 inch approach diameter, made to accommodate the 13.5 inch long OFC wire-coil inserts. A matrix of OFC wire-coil inserts is fabricated in house with wire diameters ranging from 0.035–0.125 inches and different coil pitches ranging from 0.091–1.00 inches. Water is deionized, sterilized, filtered, and sent through a slip stream flow system with circuits designed to test flow rates across laminar, transitional, and fully rough turbulent flow regimes. Flow rate and temperature readings are collected and reduced to dimensionless quantities used to develop forced convection heat transfer empirical equations correlating channel size, wire diameter, wire-coil pitch, mechanical fluid properties, and bulk fluid velocity of the DI water through turbulent flow. The correlation established will provide thermal engineers functions that predict coil pitch and wire size based upon design geometry and heat transfer needs.

Humidity Control Instrumentation: Sensing and Generation. *Obafemi Otelaja* (*Howard University, Washington, DC*); *Lin Yang* (*Brookhaven National Laboratory, Upton, NY*). The hydration level of open samples used in X-ray scattering experiments is changed by varying the relative humidity (RH) in a temperature controlled, aluminum sample chamber. The traditional relative humidity sensors used in these sample chambers usually have a slow response, and they are susceptible to damage at very high RH. The aim of this work is to realize a precise and durable method for humidity control using chilled mirror dew point hygrometer for RH sensing, divided-flow volumetric mix ratio technique for RH generation, and a newly designed temperature controlled and monitored sample chamber. By flowing helium gas, of predetermined flow rate, through a fritted gas dispersion tube into a flask containing temperature controlled water, the wet gas leaving the flask would be saturated at the water temperature. The wet gas is mixed with dry helium, also of predetermined flow rate, and the mixture is maintained at the saturation temperature and flown through the chilled mirror sensor into the sample chamber. From the chilled mirror sensor, we could obtain the dew point temperature, and with a four-wire surface platinum resistance temperature detector (PRTD) placed inside the sample chamber; we could obtain the sample temperature. Hence, we could determine the relative humidity in the sample chamber as a ratio of actual vapor pressure to saturated vapor pressure, since vapor pressure and saturated vapor pressure depend on dew point and sample temperature respectively.

Investigating Further Applications of Electric Power Grid Data Visualization Using GreenGrid Software. *Jeff Otto* (*The University of Idaho, Moscow, ID*); *Kevin Schneider* (*Pacific Northwest National Laboratory, Richland, WA*). Clear and concise system reports are essential for the proper operation of the nation's electricity infrastructure. The GreenGrid visualization program was developed to give system operators and planning engineers an effective visualization of the nation's electricity infrastructure. Using this program in real-time will allow system operators to detect the presence and location of potential system vulnerabilities. With the existence of potential system vulnerabilities identified, the operators will gain a better situational awareness, be able to reduce the occurrence of blackouts and mitigate their impact when they do occur. While GreenGrid shows promise, it is still in the prototype phase and requires validation. Research was conducted to identify where GreenGrid would be of the most use as a visualization tool. Tests were conducted by comparing the visualization of power system characteristics under both normal and stressed conditions. GreenGrid was ultimately shown to produce distinct visual indications of increased power flow through constrained transmission areas. The evidence produced by this experiment further solidifies GreenGrid's position as a truly novel and useful visualization program.

Effect of Deposition Temperature on the Crystallinity and Resistivity of ZnO Films by Atomic Layer Deposition Using DEZ and H_2O. *Victor Oyeyemi* (*Goshen College, Goshen, IN*); *Jeffrey Elam* (*Argonne National Laboratory, Argonne, IL*). ZnO films were deposited by atomic layer deposition using diethyl zinc (DEZ) and ozone as precursors. The depositions were done at temperatures ranging from 50°C to 350°C, and the effect of the different temperatures on growth rate, film morphology, crystallinity and resistivity characterized. It was found that ZnO exhibits linear growth with respect to the number of ALD cycles, and with a rate that increases with increasing deposition temperature; the rate for the 150°C deposition being 0.6Å/cycle. Surface roughening increases with temperature. Scanning electron microscopy shows grain sizes that get bigger with temperature. Also, there is a ZnO (002) preferred crystal orientation. The film resistivity decreases with growth temperature for temperatures less than 300°C but increase sharply for higher temperatures. The minimum resistivity of 0.04O was recorded for the 250°C film. Measurement of carrier mobility of the films shows a near inverse relationship with resistivity.

A Piping Flow Diagram: Verifying the Nitrogen Supply System for Argonne National Laboratory Building 212. *Sophia Pan* (*Swarthmore College, Swarthmore, PA*); *Elizabeth Grom* (*Argonne National Laboratory, Argonne, IL*). There is a significant need to maintain accurate records for configuration management of nuclear facilities at Argonne National Laboratory. Building 212 at Argonne National Laboratory contains the Alpha-Gamma Hot Cell Facility that is presently used to handle and process radioactive material. An important aspect of creating safe working conditions is the maintenance of an inert atmosphere within the hot cell, due to the storage of pyrophoric material. This project involves the verification and updating of the system schematic for the existing safety-significant nitrogen supply system piping and valves showing the flow of nitrogen into Building 212 as well as for an H-wing as-built document of the nitrogen storage tanks and vaporizers. The updated nitrogen flow schematic includes drawings of pipe lines, the numbered valve system, which controls the flow of nitrogen gas into the building, and two nitrogen tanks — a main and auxiliary tank — that hold the nitrogen supply. The H-wing as-built includes the two nitrogen tank plan views as well as two detailed elevated views. When the updated schematic and H-wing as-built are approved, they will be added to the Document Control Center archives in Building 214. It is important to keep careful records of system as-built diagrams for routine maintenance, system updates, or in the event of an emergency at the laboratory.

Post Occupancy Evaluation Review of Six Sustainably-Designed Buildings. *Anna Passernig* (*University of California – San Diego, La Jolla, CA*); *Kim Fowler* (*Pacific Northwest National Laboratory, Richland, WA*). Post occupancy evaluations (POEs) are used to measure the impact of a building compared to a baseline. This report analyzes POE energy and water data for six sustainably-designed government buildings compared to design expectations, and industry standards for energy and water use. A considerable amount of literature is available focused on the design and construction of "sustainably-designed" buildings. With hundreds of buildings in operation and thousands of buildings pursuing sustainable design strategies, investors want to know how well these buildings perform. Sustainable design is integrated design balancing the impacts on cost, the environment, and the occupants. Integrated design incorporates resource-efficient construction, renovation, operation, maintenance, and demolition. Currently, it is assumed that if a building meets the sustainable design standards, that it will be a "better" building than a "typically" designed building. POE studies offer an opportunity to analyze the performance of these buildings. Although the sample size for this study was limited, it was observed that the sustainably-designed buildings were performing better than "typical" buildings in many cases, and some performed even better than expected. There are many extenuating factors impacting building operations and these factors need to be investigated further before definitive statements can be made. However, with the awareness of the magnitude of impact that buildings have on the environment, designing, constructing, and operating sustainable buildings has the potential of significantly lessening the anthropomorphic environmental impact.

AirMagnet System Installation: Securing and Assuring the Advanced Photon Source Wireless Network. *Marya Pearson* (*Norfolk State University, Norfolk, VA*); *Ken Sidorowicz* (*Argonne National Laboratory, Argonne, IL*). Using a wireless network in a government research enterprise raises concerns of security breaches, signal interference, and internet connectivity. Initially, the wireless network at the Advanced Photon Source (APS) was vulnerable because efficient managing tools were not available. The AirMagnet system, manufactured by AirMagnet Incorporated, is a security software utility which provides a secure overview of the wireless network. New AirMagnet technology detects and reduces wireless vulnerabilities at the APS through a system of monitoring software and spectrum sensors. Following the system's installation on the APS site, spectrum evaluations were conducted to gather information on the network's performance. AirMagnet's survey-planner feature was used to scan the ring and each floor of APS for radio frequency signal data. In response to user complaints of poor internet connection, spectrum analyzer and laptop analyzer were enabled to identify devices that were affecting the wireless signal. The survey-planner's RF signal distribution prompted adjustments to the signal strength and the access point channel allocations. Information gathered using spectrum analyzer and laptop analyzer implicated unknown rogues and channel interference affecting the network. In addition, the programs offered troubleshooting solutions for each alarm. Subsequently, the spectrum evaluations improved the wireless network environment. Using the AirMagnet system as an administrative tool minimized speculation and time-consuming tasks related to network problem-solving.

Air Transport of Commercial Spent Nuclear Fuel (SNF) Assemblies. *Giancarlo Pena* (*Florida International University, Miami, FL*); *Jonathan M. Haire* (*Oak Ridge National Laboratory, Oak Ridge, TN*). The world is experiencing transformations as energy prices increase, and nuclear technology is not an exception. However, the method of transporting spent nuclear fuel (SNF) has not changed in decades. Currently in the U.S., SNF casks are shipped by train, truck, and ship. This work examined the technical feasibility of transporting SNF casks by aircraft. Air transport of research reactor SNF has already occurred between countries because of geographical and political reasons. It is concluded that air transport of commercial spent nuclear power reactor fuel is feasible in the U.S. with as many as 21 fuel assemblies shipped at one time. The major constraint that limits the number of SNF assemblies is the lift weight of the aircraft. This study uses the maximum aircraft payload as 154 tons — the net payload of the Boeing 747-8 air freighter. Existing casks from different private companies were analyzed. Sensitivity analyses were performed for transporting different numbers of SNF assemblies. The smaller the number of SNF casks transported, the lower the cask weight. Shielding analyses were conducted using ORNL computer codes CAPSIZE, SCOPE, and SCALE, the objective when using these codes was to optimize the amount of radiation shielding, while meeting regulatory radiation dose requirements. Impact crash analyses were conducted with CTH code to demonstrate crash compliance regulations. Recently, the U.S Department of Energy (DOE) submitted a license application for a permanent geological repository in Yucca Mountain, Nevada. The cost of air shipments of SNF assemblies to surface storage for SNF at Yucca Mountain is less than the costs of building the proposed railway spur to the Yucca Mountain geologic repository. Nuclear power is essential if the world intends to reduce the levels of greenhouse gases that warm the earth and by adopting this method of transporting SNF, time and costs will be reduced.

Evaluation of Technologies for Protected Asset Management. *Ben Peters* (*Maryville College, Maryville, TN*); *Chris A. Pickett* (*Oak Ridge National Laboratory, Oak Ridge, TN*). Protected asset management is a valuable concept that incorporates rigorous accountability and various layers of security. Both of these aspects

are necessary to create a robust protected asset management system (PAMS). Radio frequency identification (RFID) tags were tested for basic accountability purposes, and seals were tested for asset security. The RFID tag system tested for accountability was based on an IEEE standard called RuBee. The RuBee system uses a low frequency RF-tag, antenna, and reader to aid in locating and tracking assets. Multiple RuBee antenna designs and sizes were tested to determine the best configuration for monitoring assets in a room. The best design appeared to be a single-loop antenna that consisted of three connected coils. To test this configuration tags were placed in the antenna's field to check whether the tag was seen in various positions throughout the room. Preliminary results indicate that this antenna design adequately detects tags throughout the entire area and could possibly be used in the future as a piece of an effective PAMS. The security aspect of a PAMS was tested using Russian rope seals. This seal consists of a seal body, metal connecting rope, and a plastic optical insert that possesses a serial number that is read and stored by an automatic seal identifier. A test group of ten seals was used to determine the ease of use, time for set-up, and overall performance of the seals. These seals were first assembled and attached to a metal storage drum. They were then stored in the automatic seal identifier's memory and checked three times daily. Some design issues with the seal body and plastic optical insert need to be resolved before the seals are actually used in the field. More testing needs to be conducted in order to develop more specific recommendations for the improvement of both systems and to determine their possible uses in protected asset management.

Comparison of Commercial Office Buildings Using the NC3 Database. *Kimberly Petty* (*Washington State University, Pullman WA*)*; Emily Rauch* (*Pacific Northwest National Laboratory, Richland, WA*). The effects of global climate change and the significant use of energy in the building sector of the United States has caused huge concern and prompted shifts to more sustainable building practices. In order to track the nations' progress in improving building practices, analysis of current building practices must be done to create a benchmark. The National Commercial Construction Characteristics (NC3) database was formed in 2001 to provide such a benchmark by including building data from construction plans ranging from 1996-2007. Information collected includes general building information, envelope data, heating ventilation and air conditioning (HVAC) data, water heating data, and light fixture data. This information is gathered from design plans out for bid in the United States using the Dodgeview software that enables the user to perform take-offs from construction plans. With the information available in the NC3 database, an analysis comparing old and new office buildings was done to determine changes in the construction industry. Results showed that some changes have occurred within the eleven year time span. Differences were seen in the types of windows, wall and roof frames, water heating and HVAC fuel types, cooling distribution equipment, and lighting technology types. These suggest that the construction industry is starting to incorporate newer technologies and methods that will improve building function, increase energy efficiency, and help protect our natural resources.

Improving Roadway Safety by Implementing Wireless Inspection Systems for Tractor Trailers. *Randall Plate* (*Cedarville University, Cedarville, OH*)*; Gary Capps* (*Oak Ridge National Laboratory, Oak Ridge, TN*). According to the Federal Motor Carrier Safety Administration (FMCSA) there were over 144,000 large trucks involved in fatal and non-fatal crashes in 2005. Their Large Truck Crash Causation Study revealed that 56 percent of fatal truck crashes are due to truck-driver error and the majority of vehicle failure-related crashes are due to brake failure. Safety inspections can help prevent such occurrences by identifying drivers who have driven too long or trucks that are unsafe. However, with over 8 million commercial trucks (10,000 lbs. or greater) on U.S. roads today, officials are limited by the lengthy manual inspection process to performing only about 3 million safety inspections per year and see a violation rate of approximately 72 percent. It is estimated that an electronic device that could collect vehicle and driver information electronically and wirelessly transmit this inspection data to the roadside could greatly expedite the inspection process, thereby increasing the number of safety inspections carried out each year to approximately that of weight inspections: about 82 million. The present project is the first of three phases of Oak Ridge National Laboratory's Wireless Roadside Inspection program. It will begin examination of the technical and legal issues surrounding the implementation of a Universal Wireless Inspection System (UWIS), assemble prototype technology, test the functionality of this equipment, and report on the feasibility of implementing such a device in commercial vehicles. This UWIS will be capable of accepting driver input for identification purposes and hours of service recording, as well as information from the vehicle's onboard data bus (J-1708 and/or J-1939) to monitor vehicle status. It will then format this information and transmit it to either the roadside or a patrol car via a pair of wireless transceivers. Software that will be used at the receiving end to collect the data from the transceiver and display it for inspection officials is also currently being developed. FMCSA's Federal Motor Carrier Safety Regulations as well as information gathered from the Tennessee Department of Transportation will guide the development of this technology by providing data set content and operational requirements. Proof of concept testing is scheduled to begin in June of 2007, with a full field operational test to follow in 2008.

***Electricity Market Complex Adaptive System (EMCAS) as a Tool for Teaching Undergraduates about Power Market, Environmental Policies and Renewable Energy.** *Angel Reyes, Luis Rodriguez* (*University of Puerto Rico, Mayaguez, PR*)*; Eduardo I. Ortiz-Rivera* (*Argonne National Laboratory, Argonne, IL*). Electricity Market Complex Adaptive Systems (EMCAS) is the next generation energy and environmental market simulation tool developed recently by Argonne National Laboratories. EMCAS simulates the behavior of restructured power market participants using an agent-based complex adaptive systems approach. EMCAS provides an agent based framework to capture and investigate the complex interactions between the physical infrastructures and the economic behavior of market participants that are a trademark of the newly emerging markets. As an introduction for the EMCAS software simple cases were studied in order to understand the capabilities of this analytical tool. The eleven node and the central European cases were hypothetical cases in which the main functions of EMCAS were studied. After that, the simple market of Puerto Rico's grid was studied using EMCAS to analyze how the system behaves. Also, the effect of the Hurricane George and the Palo Seco's power plant fire on the system of the Puerto Rico Electric Power Authority was analyzed. Future studies will include the analysis and the development of the system in the next couple of years, the effect of adding new transmission lines in the transmission system and the addition of renewable energy sources in the island's power system. Electricity Market Complex Adaptive Systems (EMCAS) is the next generation energy and environmental market simulation tool developed recently by Argonne National Laboratories. EMCAS simulates the behavior of restructured power market participants using an agent-based complex adaptive systems approach. EMCAS provides an agent based framework to capture and investigate the complex interactions between the physical infrastructures and the economic behavior of market participants that are a trademark of the newly emerging markets. As an introduction for the EMCAS software simple cases were studied in order to understand the capabilities of this analytical tool. The eleven node and the central European cases were hypothetical cases in which the main functions of EMCAS were studied. After that, the simple market of Puerto Rico's grid was studied using EMCAS to analyze how the system behaves. Also, the effect of the Hurricane George and the Palo Seco's power plant fire on the system of the Puerto Rico Electric Power Authority was analyzed. Future studies will include the analysis and the development of the system in the next couple of years, the effect of adding new transmission lines in the transmission system and the addition of renewable energy sources in the island's power system.

Platform for Secure Remote Access to Sensors through an Ethernet Network. *Nathan Rowe* (*University of Tennessee, Knoxville, TN*)*; Chris Pickett* (*Oak Ridge National Laboratory, Oak Ridge, TN*). In Nuclear Material Safeguards, sensors are frequently used to verify material attributes during processing, transportation, and storage. The ability to remotely read and configure these sensors, with confidence in the security and accuracy of the transmission would significantly reduce the need for on-site inspections. A compact and secure sensor platform was designed by the student to meet these needs. The sensor platform measures 56 by 24 by 22 mm and provides secure communications, general purpose I/O ports, a dedicated bus for interfacing with various types of sensors, and is fully web enabled. The system is powered over Ethernet, which not only minimizes installation complexity and cost, but also allows the sensors to be distributed away from customary power sources. Support for encryption and authentication protocols at the sensor ensure that the platform is suitable for high security deployments. A compatible Geiger Mueller radiation detector sensor board was also designed by the student to serve as a proof of concept demonstration. The design shows promise for use in many distributed sensor applications. Remaining steps include further testing of the platform, improved end user software, and further development of compatible sensor packages, including a potential radio frequency based design.

Use of Hollow Fiber Membranes in Liquid-liquid Extraction of Ethanol from Corn Fermentation Broth. *Neha Rustagi* (*University of Maryland, College Park, MD*); *Seth Snyder* (*Argonne National Laboratory, Argonne, IL*). Fermentation of dextrose produced by enzymatic reactions with corn starch is one of the essential steps in ethanol production from corn, and filtration of ethanol from the fermentation broth is subsequently necessary for ethanol recovery. Currently, separation of the ethanol from the fermentation broth is typically accomplished with pervaporation; however, a less energy intensive process that also yields higher ethanol recovery is the use of ionic liquid to perform liquid-liquid extraction of the ethanol in a device known as a membrane contactor. In this project, the use of hydrophobic hollow fiber membranes in a membrane contactor to filter out ethanol and ionic liquid from a fermentation broth is being investigated. The hydrophobicity of the membranes is intended to prevent passage of water and other dissolved materials in the fermentation broth; thus, only the ionic liquid and ethanol should pass, and the ionic liquid will subsequently be removed from the ethanol with distillation. Hollow fiber membranes are expected to yield greater flux than the flat sheet membranes currently in use due to their significant surface area. The flux through the membranes will be assessed by measuring the volume of permeate produced in a given amount of time; ideally, the flow will be around $5.258 * 10^{-8} m^3/s$, which is around 3% of the total influx of fermentation broth into the contactor. The pressure output by the pump in the membrane contactor will be adjusted to help produce this flow. The effectiveness of the membrane as a filter will be assessed by use of high performance liquid chromatography (HPLC) to detect the presence of unwanted substances in the permeate. Ideally, the permeate will only contain the ionic liquid 1-butyl-1-methylpyrrolidinium and ethanol. The membranes to be tested were chosen based on their pore sizes or molecular weight cutoff values. The pores in the membrane should block the passage of bacteria, which is around 5 μm in length and $6 * 10^8$ kilodaltons in weight. The flow rate and ability of the membrane to filter bacteria and fermentation broth out of the feed solution will determine the hollow fiber membrane's effectiveness in the contactor unit.

Well-to-Wheel Analysis of Renewable Fuels in Hybrid and Plug-In Hybrid Vehicles. *Christine Ryan* (*University of Colorado, Boulder, CO*); *Mathew Thornton* (*National Renewable Energy Laboratory, Golden, CO*). Well-to-Wheel (WTW) analyses have been used for a number of years to understand the energy and environmental impacts of various types of fuel and vehicle systems. As the issues of reducing America's dependence on petroleum and decreasing transportation sector emissions become increasingly important so do WTW analyses on the vehicle and fuel systems of the future in order to understand appropriate pathways. Plug-In Hybrid Electric Vehicle (PHEV) technology and renewable biomass fuels have the potential to significantly reduce the petroleum consumption of the transportation sector and in turn the United States as a whole. Using the Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET) model developed by Argonne National Laboratory, WTW analyses were conducted for 12 vehicle/fuel systems. Baseline spark-ignition (SI) and baseline compression-ignition (CI) engines were compared to HEV and PHEV vehicles using various fuels; reformulated gasoline (RFG), low-sulfur diesel (LSD), 20% biodiesel blend (BD20), and 85% ethanol blend (E85). The result of using E85 and B20 shows an over all reduction in the use of fossil fuels, in both HEV and PHEV models when compared to the baseline RFG vehicle, and this reduction is larger when renewable fuels are used. The largest reduction was seen with a HEV vehicle paired with E85 fuel. PHEV vehicles also saw reductions in fossil fuel use, with a PHEV40 reducing the fossil fuel use more when compared to an HEV using RFG fuel. PHEVs have greater petroleum reductions than HEV vehicles with all fuel types used. Emissions from PHEV and HEV models differ as fuels change. The greatest reduction in CO_2 emissions was seen with E85 fuel used in an HEV, with a reduction of 58.7% .

Evaluating the efficacy of mustard (*Sinapis alba*) seed meal as an organic control method for invasive Harding grass. *Gregory Rybka* (*Pennsylvania State University, University Park, PA*); *Robert Van Buskirk* (*Lawrence Berkeley National Laboratory, Berkley, CA*). Biodiesel is widely viewed as an alternative to fossil-based fuels. The production of oil for biodiesel by pressing mustard seed has been studied and found to be feasible though the process has shown to be uneconomical. White mustard meal (*Sinapis alba*) contains glucosinolates (GLS) which when hydrolyzed break down into toxins to various plants, such as ionic isothyocianate and thyociante. The research reported in this study considers using the remaining mustard seed meal as an organic bioherbicide to control Harding grass, an invasive plant in California. A randomized complete block experimental design was employed in field trials, involving four treatments of mustard meal applied at varying rates of 0.5 t/acre, 1 t/acre, 4 t/acre and 0 t/acre (the control). The treatments were applied to two plots each with 16 subplots, where one plot had above ground (AG) biomass removed prior to application and on the other no removal took place. The subplots were initially characterized by the quantity of Harding grass per unit area, at 20%, 40%, 60% and 80% coverage. On all subplots water was applied exclusively by rainfall and totaled 1.5 inches. After six weeks, the Harding grass was removed and weighed; the water content of the removed grass was measured in order to determine the AG biomass for each subplot. The average AG biomass of all treated plots and that at each application rate were larger than that for their respective control subplots, though using an analysis of variance the data sets were not found to be statistically different. The initial and final measurements of Harding grass were also found to have discrepancies as they were negatively correlated for the control plots, indicating an issue with the use of both area and mass measurements. Due to the lack of statistically significant evidence it is not possible to draw conclusions on the potential of mustard meal as economically supporting mustard seed as a source for alternative fuel.

Applied Material and Energy Evaluation for Biomass Gasification. *Isaac Sachs-Quintana* (*New Mexico Institute of Mining and Technology, Socorro, NM*); *Calvin Feik* (*National Renewable Energy Laboratory, Golden, CO*). As gasoline prices continue to climb, and the price of corn increases, the thermochemical conversion of lignocellulosic biomass into fuels becomes more economical. Economic modeling is the primary tool for assessing the feasibility of biomass conversion processes. Material and energy balances on experimental data are needed to validate the theoretical economic models. Material and energy balances were performed on a pilot scale biomass gasification plant. The plant's gasifier, thermal cracker, and tar reformer were considered. Usable data was extracted from the pilot plant's data acquisition system. Differentiation and integration were performed to achieve a basis of calculation. Input and output flows were compared, and material and energy closures were executed. The average material closure for the gasifier, thermal cracker, and tar reformer were 74.34% ± 28.77%, 97.71% ± 3.129%, 100.1% ± 15.05%, respectively. The average energy closures for the thermal cracker and the tar reformer are 107.9% and 101.3% respectively. At the moment, an energy closure for the gasifier cannot be determined because of insufficient data. The experimental data for the tar reformer and thermal cracker can readily be used for validating economic models. The gasifier data cannot. Additional tests in the pilot plant are required to obtain more accurate material and energy streams.

Temperature Distribution in a Hydrogen Fuel Cell Stack. *Robert Schulz Jr.* (*State University of New York at Farmingdale College, Farmingdale, NY*); *Devinder Mahajan* (*Brookhaven National Laboratory, Upton, NY*). With global warming and energy resource shortages continuing to threaten our environment and national economy, fuel cells hold an excellent potential for a clean and reliable source of energy. Hydrogen fuel cells will help maintaining a healthy environment by eliminating harmful emissions and reducing the green house effect. The main objective of this project is to obtain an empirical formula for the relationship between the power output of this stack and the operating internal bipolar plates' temperature. This formula will be utilized in producing an efficient and cost effective design of the power stacks' cooling system. Three different bipolar plates located in the front, middle and end of the fuel cell stack were fitted with five thermocouples to each plate, to monitor the stack temperature in real-time as it operates at various power levels. Lab View, a Data Acquisition System, was connected to these fifteen thermocouples to collect and record the stack's internal temperature. The bipolar plates were fabricated with 40 cm^2 active area and the stack was supplied with hydrogen and air at a stoichiometry value of 3. The current was increased in increments of 0.1 amps and the resulting voltage, power, and 15 thermocouple temperature readings were recorded. This process was continued until the voltage almost dropped to zero. The experimental stack average temperature followed the expected trend and showed steady increase with the applied electric load; however, the fuel cell stack temperature was limited to 80°C to prevent Membrane Electrode Assembly (MEA) damage. In conclusion, the designed cooling system should help maintain a steady state environment for the cell stack. The cooling system will consist of 2 or more electric fans that will help to increase the heat transfer from the cell, reducing the temperature. This process will be used to find the ideal current, voltage, and power levels that will maximize the cell stack's performance while maintaining a relative cooling process of the cell stack.

Plug-in Hybrid Electric Vehicle and Hybrid Electric Vehicle Emissions under FTP and US06 Cycles at High, Ambient, and Low Temperatures. *Matthew Seidman* (*California State Polytechnic University, Pomona, CA*); *Tony Markel* (*National Renewable Energy Laboratory, Golden, CO*). The concept of a Plug-in Hybrid Electric Vehicle (PHEV) is to displace consumption of gasoline by using electricity from the vehicles large battery pack, to power the vehicle as much as possible with minimal engine operation. This paper assesses the PHEV emissions and operation. Currently, testing of vehicle emissions is done using the federal standard FTP4 cycle on a dynamometer at ambient (75°F) temperatures. Research was also completed using the US06 cycle. Furthermore, research was completed at high (95°F) and low (20°F) temperatures. Initial dynamometer testing was performed on a stock Toyota Prius under the standard FTP4 cycle, and the more demanding US06 cycle. Each cycle was run at 95°F, 75°F, and 20°F. The testing was repeated with the same Prius retrofitted with an EnergyCS Plug-in Hybrid Electric system. The results of the testing confirm that the stock Prius meets Super-Ultra Low Emission Vehicle requirements under current testing procedures, while the PHEV Prius under current testing procedures were greater than Super-Ultra Low Emission Vehicle requirements, but still met Ultra Low Emission Vehicle requirements. Research points to the catalyst temperature being a critical factor in meeting emission requirements. Initial engine emissions pass through with minimal conversion until the catalyst is heated to typical operating temperatures of 300–400°C. PHEVs also have trouble maintaining the minimum catalyst temperature throughout the entire test because the engine is turned off when the battery can support the load. It has been observed in both HEVs and PHEVs that the catalyst is intermittently unable to reduce nitrogen oxide emissions, which causes further emission releases. Research needs to be done to combat the initial emission spikes caused by a cold catalyst. Research also needs to be done to improve the reduction of nitrogen oxides by the catalyst system.

AC Losses in YBCO Superconducting Cables. *Daniel Sims* (*Tennessee Technological University, Cookeville, TN*); *Robert Duckworth* (*Oak Ridge National Laboratory, Oak Ridge, TN*). To better supply power to dense urban areas, superconducting power cables are one solution that can accomplish this within existing electrical ductwork. While “first generation” Bi-Sr-Ca-Cu-O (BSCCO) tapes are currently being used in several demonstration cable projects around the world, its cost may limit the market penetration of commercial superconducting cables. As a potential low cost alternative, “second generation” Y-Ba-Cu-O (YBCO) tapes have started to meet and exceed the current-carrying performance of BSCCO tapes with lengths greater than 100 m and could be used in superconducting cables in the near future. AC loss, which is the amount of heat generation of a superconducting cable under ac current, is a critical design parameter since it directly impacts the size of the cryogenic refrigeration system and thus impacts the overall cost. The goal of this project is to make a technical evaluation of current YBCO tape architectures, which are currently being supplied in the United States by American Superconductor (AMSC) and SuperPower (SP). Prototype cables with lengths of 1.25 m and former diameters of 3.81 cm were made from the 4-mm wide YBCO tapes to evaluate the effect of the tape architecture on ac loss. A well-established electrical measurement method and a thermal measurement method were employed to accurately characterize each cable. A finite element model was used to make sure that the heater used in the thermal method was sized appropriately to match the heat generated by the cable. As a measure of the cable performance, the critical current was measured under dc conditions and was found to be 5380 A for the AMSC cable and 4400 A for the SP cable, which agreed well with the single tape critical current for each type of YBCO. With respect to the measured electrical ac loss at 3 kArms, the AMSC cable was 3 W/m, while the SP cable was 6 W/m. While this might indicate some advantage to AMSC YBCO tapes, comparing the ac loss in each cable as a function of the ratio of the peak current to the cable critical current showed the functional dependence of each cable to be similar as the current approached 3 kArms. Comparing the ac loss measurement methods, differences between the thermal and electrical ac loss measurements suggest refinement of the thermometry is needed and is currently under further investigation.

Preliminary form and footprint studies for the integrative design of NREL Research Support Facility. *Michael Smith* (*Portland State University, Portland, OR*); *Paul Torcellini* (*National Renewable Energy Laboratory, Golden, CO*). Commercial buildings currently account for 18% of annual U.S. energy consumption. The U.S. Department of Energy (DOE) has established the goal of achieving market viable commercial zero-energy buildings by 2025. A net zero-energy building (ZEB) is a building with significantly reduced energy demand through efficiency improvements such that the remaining energy needs can be supplied with onsite renewable technologies. Building design problems are inherently multivariate and multi-objective, encompassing a large number of parameters to consider. Balances must be researched and found to maximize an overall net gain in performance. A whole-building or integrative design approach takes into account the interactions among the subsystems of a building and requires collaboration through interdisciplinary design teams which includes key players throughout the building process. On March 16th, 2007, the DOE approved $73 million to design and construct a new administrative building termed the Research Support Facility (RSF). DOE and NREL view this as an opportunity to create a national showcase how aggressive energy efficiency goals can be achieved. The studies covered in this report are intended to provide recommendations for key players involved in the process of designing the RSF. The studies are focused on early-phase preliminary design decisions. The emphasis is on examining the effects of building form and footprint on the energy performance of a building. This assessment is simulation-based, systems integration analysis using NREL’s Opt-E-Plus software based on DOE’s EnergyPlus building simulation program to model the energy performance of different options for the RSF. The results are analyzed to develop recommendations for optimal building shapes that take into account trade offs between energy use for heating, cooling and lighting. The recommended floor plate is roughly rectangular with an aspect ratio of 2.5, floor-to-floor height of 12.5 ft, and the longer walls of the building facing north and south. Meeting the RSF’s goal of energy use intensity of 25 kBtu/ft^2•yr should be possible as long as typical energy efficient measures are applied, plug loads do not exceed 0.5 W/ft^2, and installed lighting loads are around 0.7 W/ft2.

Revising the Building Combined Heat and Power (BCHP) Screening Tool. *Rodney Smith* (*University of Tennessee, Knoxville, TN*); *F. Ed Pierce* (*Oak Ridge National Laboratory, Oak Ridge, TN*). The United States Government created the Federal Energy Management Program (FEMP) in order to reduce the electricity consumption of its agencies. One method by which the program meets this goal is development and application of combined heat and power (CHP), or cogeneration, technology. In a typical CHP system, the waste heat from an on-site turbine or engine is recovered and used for heating the surrounding building or area. In order to assess the economic feasibility of this technology, a screening must be performed that simulates the layout and energy usage of a candidate site. ORNL uses a computer program called the BCHP Screening Tool for this purpose. However, the particular version of this software in use at the lab is lacking in its capabilities and appearance. Thus it has been my goal to revise the source code of this program so as to remove as many such deficiencies as possible. The revisions made can be divided into three categories: debugging, reformatting, and upgrading. First, debugging efforts primarily focused on avoiding error messages that were called inappropriately or at inconvenient times, such as when certain pieces of equipment were omitted. Next were reformatting changes, which included revising the system font and layout to something more modern and rearranging objects where space limitations had cut off words or lines. Finally, upgrading changes made the program more user-friendly, such as by allowing single-case simulations and adding additional user-defined parameters. Work is still in progress, as the screening tool is inherently dated by its Visual Basic/FORTRAN architecture. Future developments may include interaction with Excel-based input forms and further modification of the program’s appearance.

Effect of Oxygen Annealing on Substrates for Complex Oxide Film Growth. *Ryan Smith* (*Case Western Reserve University, Cleveland, OH*); *Hans Christen* (*Oak Ridge National Laboratory, Oak Ridge, TN*). In this investigation, the optimum annealing conditions (temperature and atmosphere) yielding atomically flat surfaces on the crystalline material $NdGaO_3$ were examined. This material is used as substrate for thin-film pulsed laser deposition (PLD) of various complex oxide films, including, for example, Yttrium Barium Copper Oxide (YBCO), a high-temperature superconductor (HTSC) based on the perovskite crystal structure. Since their discovery over 20 years ago, HTSCs have been thoroughly investigated because they exhibit superconducting properties (zero resistance) above the boiling point of liquid nitrogen (77 K). Thin films of these materials have shown improved superconducting properties, which are highly dependant on the defect structure of the film. Recently, new complex oxide substrates for YBCO deposition have been investigated, including LSAT ($(La,Sr)(Al,Ta)O_3$) and $NdGaO_3$, because of their similar thermal expansion coefficient, good dielectric properties, and small lattice parameter mismatch with YBCO compared to traditional sapphire

substrates. Such a perovskite substrate with atomically flat terraced surface terminated in regular unit-cell high steps is essential for high quality epitaxial YBCO films with low or controllable defect density and optimal superconducting properties, as well as for other metal-oxide films (ferroelectrics, colossal magnetoresistive (CMR) materials, etc.). Perovskite-type ABO_3 crystals with at least two cation species, like $NdGaO_3$, can terminate in either "A-site" (AO) or "B-site" (BO_2) layers on the crystal surface. Unlike most substrates considered for oxide film growth (e.g., $SrTiO_3$), thermal annealing of NdGaO3 results in an A-site layer termination. Studies of YBCO film deposition have shown that A-site layer termination prevents the segregation of deleterious copper precipitates, and thus such substrates are highly desirable for HTSC growth. Single crystal (001) $NdGaO_3$ substrates were thus annealed in air and oxygen, and the resulting surface morphologies were investigated by atomic force microscopy (AFM). The optimum annealing conditions for annealing were found to be 1100°C for 1 hour in an argon (or other inert gas) atmosphere, although annealing in air yields acceptable results.

Fabrication of an Emergency Shutdown System for a Hydrogen Production System. *Kurt Stuart* (*Monmouth College, Monmouth, IL*); *Greg K. Krumdick* (*Argonne National Laboratory, Argonne, IL*). Hydrogen sulfide (H_2S) gas is a toxic byproduct of the petroleum and mining industry with little to no commercial value. Hydrogen sulfide is considered a broad-spectrum poison that affects the respiratory system. Exposure to levels as little as 100 ppm can lead to eye damage, olfactory nerve paralyzation, and at 500 ppm can lead to pulmonary edema, loss of breathing and death. This experimental process involves the use of high concentrations of H_2S. In order to run experiments safely, a sophisticated emergency shutdown system needed to be designed and fabricated. This system requires sensors for the various gasses used in the process, including H_2S, Sulfur Dioxide, Methane, and Hydrogen as well as alarms and control equipment to automatically shut down the system if a critically toxic gas exceeds a safe limit. The system also monitors airflow throughout the hoods used in this experiment to ensure it is at a level to allow the experiment to be safely conducted. The shutdown system also includes an emergency shutdown button that can be depressed to shut the system down in the case of a general emergency. Currently, the system includes gas sensors for H_2S located in the ventilation ductwork, an airflow sensor, and an emergency shutdown button mounted on the main control panel. This emergency shutdown system demonstrates the high level of safety taken into consideration to protect workers from the hazards of this experiment.

A Networked Control/Data Acquisition System Based on the ColdFire Microprocessor. *Ilya Sukhanov* (*State University of New York at Stony Brook, Stony Brook, NY*); *Edward Kistenev* (*Brookhaven National Laboratory, Upton, NY*). Nose Cone Colorimeter Control (N3C) is a highly dynamic system used for slow data acquisition (DAQ), remote system control, and environmental monitoring. The N3C project utilizes an embedded ColdFire processor with the Quadros real time operating system (RTOS) which acts as a bridge between an array of hardware devices and remote-controlling machines over the TCP/IP network protocol. The requirements of this project were to build a network-capable device to program field-programmable gate array (FPGA) devices such as Xilinx and Altera. While such network-FPGA-programmers are available on the market they all only do one task, our specification called for a way to interface with other buses of the system and DAQ. N3C utilizes the feature rich ColdFire microprocessor which allows for easy access to a number of buses such as I2C, QSPI, UART, JTAG and GPIO. With the help of the N3C client one can quickly develop custom tools to remotely interface with devices via these buses. In the case of the Nose Cone Colorimeter, N3C is used to interface with most of the buses supported by ColdFire, JTAG is utilized for FPGA configuration and the systems slow control, I2C as a bridge to a Dallas 1-Wire bus which in turn is used for environmental monitoring and control, QSPI for slow DAQ read out. The N3C system is controlled via a simple control protocol over TCP and data-stream is transferred over UDP to reduce the network overhead at the cost of reliability. During the course of this project we've optimized Quadros RTOS supplied TCP/IP stack (a modified OpenTCP implementation) for our applications resulting in a ten-fold performance increase. This optimization makes it feasible to use N3C as a slow (2 MBytes/s) DAQ system. For further improvement we plan to implement a compression schema into our DAQ system. While we have only tested compression on a desktop machine the results are promising. Utilizing a variant of Hashemian coding described in the paper entitled "Condensed Table of Huffman coding, a New Approach to Efficient Decoding" by Reza Hashemian, it is possible to compress data just as well as with Huffman coding but decompression requires less memory and time. Built with flexibility in mind, N3C was developed to work on two versions of the ColdFire processor, the MCF5282 and MCF523x. Such flexibility allows for easy integration of new features and utilization of this system in projects other than the Nose Cone Colorimeter Upgrade.

Development of a Mathematical Model for Intimal Hyperplasia Due to Vascular Injury. *Nathan Summers* (*University of Tennessee, Knoxville, TN*); *Richard Ward* (*Oak Ridge National Laboratory, Oak Ridge, TN*). Intimal hyperplasia (IH) is the thickening of the arterial wall in response to an injury of the blood vessel. IH results from the migration of vascular smooth muscle cells (VSMCs) from the medial to the intimal layer of the blood vessel wall and is believed to be directed by biochemical concentration gradients, a process known as chemotaxis. The primary chemotactic biochemical appears to be platelet-derived growth factor (PDGF) which is produced by platelets adhering to the arterial wall and macrophages invading the intima. The induced migration can be quantified using individual cell tracking or through cell population assays. The parameters for individual cell assays, such as average cell speed and persistence time (the average amount of time the cell takes before it changes direction), can be related mathematically to the parameters of the cell population assays, such as the random motility coefficient (similar to a Brownian diffusion coefficient) and the chemotaxis coefficient (the directed diffusion coefficient). One of the goals of this research was to quantify this relationship using data obtained through literature searches and data obtained from experiments conducted by the Vascular Research Laboratory (VRL) of the University of Tennessee Graduate School of Medicine, Knoxville. However, the needed data from the VRL has not yet been made available, making it impossible to fully quantify the algebraic model for this relationship. It is also believed that the receptors on the cell surface of VSMCs play a key role not only in detecting but also in processing the information from the PDGF biochemical gradient. The second goal of this research was to incorporate VSMC receptor mechanics into a hybrid model (a combination of a discrete model for cellular migration and a continuous model for biochemical diffusion) of VSMC migration driven by chemoattractants. This was accomplished by writing a C++ code modeling the role cell receptors play in the cellular response due to the effect of PDGF. The ultimate goal of this research is to augment a hybrid cell migration model with receptor mechanics to study the possible deleterious affects of balloon angioplasty and the effects of hormone replacement therapy on the outcome of this procedure.

Improving Efficiency of Washington Commercial Buildings. *Danny Taasevigen* (*Montana State University, Bozeman, MT*); *Srinivas Katipamula* (*Pacific Northwest National Laboratory, Richland, WA*). Commercial buildings in Washington are currently the fastest growing electricity-consuming sector using roughly 36 percent of the state's electric energy at a cost of about $1.7 billion annually. As a result of inefficient operations of heating, ventilation, and air conditioning (HVAC) units, experts estimate that about 10 to 30 percent of this energy is wasted. To recover this wasted energy, Battelle has targeted large and small commercial buildings for re-tuning. Large commercial buildings (greater than 100,000 square feet) use sophisticated building automation systems (BASs) to manage a wide range of building equipment. These systems need periodic tuning to ensure maximum efficiency, which HVAC service providers will provide through training from Battelle. Small commercial buildings (less than 50,000 square feet) typically lack sophisticated controls, so Pacific Northwest National Laboratory(PNNL) has developed a low cost, wireless sensing control and conditioning monitoring technology that will be implemented onto these buildings' packaged rooftop units. There were two successful contributions made to the project this summer. First, specified commercial buildings provided past utility bills (March 2006 to February 2007), which allowed recording of past electric energy consumption. Then, with recorded temperature data for the corresponding month, a regression analysis was performed for each building, comparing energy consumption versus temperature. These pre-installation performance models will allow for the calculation of the baseline energy use at the end of the project. Once the buildings are re-tuned by Battelle trained service providers, monitoring will commence for the same time period. This will allow for a comparison with pre-re-tuning data, which will then provide necessary data for a savings analysis. For the small commercial buildings' wireless sensing controls, a mounting technology was designed to hold the sensor secure while attached onto the side of the HVAC unit. These sensors will monitor the unit's performance and alert service providers of maintenance issues that need attention. These contributions aid in the projects' aim at reducing and monitoring energy use in Washington buildings.

Optimization of the Hydrolysis Reaction in the Copper-Chloride Thermochemical Cycle. *David Tagler* (*University of Notre Dame, Notre Dame, IN*)*; Michele Lewis* (*Argonne National Laboratory, Argonne, IL*)*.* Several thermochemical cycles, which generate no greenhouse gases, are currently being developed to efficiently produce hydrogen. The copper-chloride (Cu-Cl) thermochemical cycle is exceptionally promising because it has been designed to operate at the relatively low peak temperature of 550°C. This project specifically focuses on the thermal hydrolysis reaction of cupric chloride, $2CuCl_2$ (s) + H_2O (g) → Cu_2OCl_2 (s) + 2HCl (g), from 365°C to 385°C at atmospheric pressure. The goal of this project is to determine the optimum operating conditions (temperature, steam to copper molar ratio, space velocity, and reaction time) to maximize the products of this reaction. Using argon as an inert carrier gas, steam is transported at 100 to 500 ml/min through a 38 cm long vertical reactor tube. $CuCl_2$ samples ranging from 300 to 500 mg are placed in a 13 mm inside-diameter crucible positioned 17.3 cm from the top of the reactor tube. Space velocities range from 10,000 to 75,000 hr^{-1}, reaction times range from 30 to 60 mins, and steam to copper molar ratios range from 17 to 66. Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) is used to analyze the solid products of the reaction. Analysis of the results shows that the composition of Cu_2OCl_2 most strongly depends on the space velocity. The mass conversion of $CuCl_2$ to Cu_2OCl_2 was optimized from 50% to about 90%. The decomposition of $CuCl_2$ to CuCl was 8%. Future studies will analyze the effect of varying the bed length to diameter ratio (L/D), sample surface area, reactor design, and transport gas.

Vulnerability Assessment of Earth Dams Subjected to Extreme Loads Using Finite Element Analysis. *Donald Tempinson* (*Southern Illinois University Carbondale, Carbondale, IL*); *Nikolaos Simos* (*Brookhaven National Laboratory, Upton, NY*). A major problem facing earth dams is that their response to seismic loads as well as other high-rate, extreme loads is difficult to assess due to the fact that a lot of the knowledge gained about seismic and other dynamic-type loading has been acquired only recently and after these earth dams were designed and constructed. One of the important areas of concern is slope failure of the embankment that can cause the dam to fail. Also of concern is the possibility of water seepage through the dam, which will weaken the structure over time. The complexity of the seismic loads, the unique geometric and material properties of the dam, and the complicated nature of soils make it difficult to assess a dam's vulnerability. To overcome this obstacle, state of the art computational techniques such as finite element analysis must be utilized to assess the vulnerability of these dams. The use of a general finite element analysis program, such as ANSYS and LS-DYNA, allows the modeling of complex structures and loads. The results from the analysis of these structures can identify possible weaknesses and allow corrective measures to be taken. Due to the sensitive nature of the research being conducted, exact results cannot be shared.

Implementing and Testing a Data Acquisition System for Use with the BigBite Spectrometer. *Brent Terres* (*Old Dominion University, Norfolk, VA*)*; Robert Michaels* (*Thomas Jefferson National Accelerator Facility, Newport News, VA*)*.* Nuclear physics experimentation relies on particle detectors whose analog signals must be digitized and archived by a data acquisition (DAQ) system. A DAQ system must digitize, format, and store all required data from an experiment so that it can be retrieved later for in depth analysis. At the Jefferson National Accelerator Facility, DAQ systems are implemented using the CEBAF Online Data Acquisition (CODA) system, a set of hardware and software devices developed specifically for nuclear physics experimentation. This project involved the implementation and testing of a new multi-crate DAQ for the BigBite Spectrometer, in Hall A at Jefferson Lab, to be used for a series of experiments to run in 2008. A trigger supervisor, a custom device that coordinates and synchronizes the data, was implemented. Next, deadtime, the time during which the hardware is busy and cannot record data, was minimized for application with the BigBite spectrometer and was found to be consistent with expectation. Finally, an analysis program was created that quickly checked the data for missing or extra hits, verified the synchronization of the data, and measure the deadtime. It was determined that a functioning DAQ system could be built for use with the BigBite spectrometer that would both meet the specification and make use of two design standards for redundancy. Also, it was determined that the DAQ system would be suitable for use with the BigBite Spectrometer. The DAQ system developed meets and exceeds the specifications required by the experiment. A properly functioning DAQ system will provide researchers with a high quantity of precise data when using the BigBite detector.

The Multicomponent Crystallization Analysis of Biodiesel at Cloud Point. *Kaitlin Thomassen* (*State University of New York at Geneseo, Geneseo, NY*)*; C.R. Krishna* (*Brookhaven National Laboratory, Upton, NY*)*.* Fatty Acid Methyl Ester (FAME), known as biodiesel, is a renewable fuel source, that when lowered in temperature crystallizes, forming a wax like solid. When compared to petroleum based distillate fuels, biodiesel reaches its cloud point between 20°C to 35°C higher depending upon the source feedstock used for production. Biodiesel is also composed of many components based on the source material from which it is made (vegetable oils such as soy, canola, palm oil etc., waste cooking oil such as yellow grease, and animal lard such as tallow), hence the importance of multicomponent crystallization studies. In order to achieve a deeper understanding of this elevated crystallization temperature, an analysis of the multicomponent crystal size, distribution, and growth rate was needed. Using a laser based optical probe that measures the chord length of particles in a liquid, the crystal size and distribution was measured at cloud point from biodiesel fuel samples derived from various feedstocks. When analyzing the crystal growth rate, it was observed for soy that there was no crystal formation, or nucleation, until cloud point was reached. For tallow however, there was nucleation observed before the cloud point. Once crystal formation occurred, the growth rate was rapid in both fuels. The crystal size distribution was similar to a bell curve, peaking with a maximum particle occurrence of roughly 8 microns. Although maximum crystal size observed was about 250 microns, the majority of crystals fell between the range of 2.5 through 21.5 microns. The agglomeration point was clearly detectable in both fuels. In soy there was a significant crystal count decrease in the 1–5 micron particle range. At this same point the 10–23 micron particle range increased surpassing the 1–5 micron crystal count. In Tallow, this transition was not as sharp. The data that has been gathered applies to several areas of interest in the industry. One of the most pertinent applications is Cold Filter Plugging Point (CFPP). The CFPP is the lowest possible temperature at which fuel can flow through a filter, at a specified flow rate, before the filter is considered clogged. The multicomponent crystallization data can be applied towards CFPP research along with research to develop additives that can improve cold flow properties. Additionally, with this data, it is possible to remove the crystal formation at the agglomeration point through filtration procedures as a means to lower cloud point temperatures. If the solution for cold flow properties of biodiesel can be ascertained, biodiesel would be a viable alternative energy source.

***Design and Implementation of a Sulfur Hexafluoride Gas Transfer System for the Free Electron Laser (FEL) Gun Test Stand.** *Brian Tucker* (*Virginia Tech, Blacksburg, VA*); *Kevin Jordan* (*Thomas Jefferson National Accelerator Facility, Newport News, VA*). Jefferson Laboratory's Free Electron Laser (FEL) program is currently developing a photocathode test gun to benchmark the performance of new gun technology for eventual use in free electron lasers. The gun uses a 500 kV DC high voltage power supply (HVPS) that connects to a high voltage stack held in a pressure vessel. When the HVPS is being used, the vessel is filled with pressurized sulfur hexafluoride (SF_6), a non-toxic, non-flammable gas that suppresses electrical discharges. Because a full vessel of SF_6 costs approximately $4,000, the gas needs be recycled so that the vessel can be opened without loss of gas. The goal of this project is to develop a system to transfer gas between the pressure vessel and a storage bag without significant loss of gas or contamination. A similar system has been used in the FEL vault for the past eight years. Analyzing the old design revealed ways to improve the gas transfer process. These improvements were used to select the new system's components. Finally, designs were made to fit the system into the Gun Test Stand vault and to mount the components to the wall. The resulting design improves the old system by implementing a more user friendly layout, automating the entire process, and taking advantage of more advanced pumps and valves. Improving the recycling of SF_6 saves time and money, while helping to ensure smooth gun operation and make HVPS maintenance routine. For now, the new system will serve as an important part of the testing process for the photocathode test gun. Eventually, the changes will be used to upgrade the system in the FEL vault.

Updating and Creating New Documentation for the PHENIX Gas Distribution System. *Jeffrey Tyler* (*Northeastern University, Boston, MA*)*; Don Lynch* (*Brookhaven National Laboratory, Upton, NY*)*.* The Physics High Energy Nuclear Interaction eXperiment (PHENIX) at Brookhaven National Laboratory (BNL) utilizes an extensive gas distribution system which supplies custom mixed gases to the various subsystems involved in the experiment. In compliance with Department of Energy (DOE) standards, it is important to have accurate and up-to-date documentation on all aspects of this gas system.

The gas system is constantly being updated with new components, gases, and mixing racks, and because of this, it is difficult to keep documentation current. As a state-of-the-art laboratory with over 4,000 annual guest users, safety is of paramount importance and it is imperative to communicate information efficiently. In order to properly document the gas distribution system all current documentation was collected, updated, and organized. This updated documentation includes Microsoft Excel spreadsheets for each gas system which lists information regarding their components, AutoCAD schematic drawings of both the gas pad and the gas mixing house, and a 3D assembly of the gas pad using Autodesk Inventor. These updated documents along with current PHENIX procedures provide a thorough and up-to-date set of documentation for the gas distribution system. This updated system allows for BNL's plethora of guest users to easily navigate through the PHENIX gas system documentation therefore creating a safer and more efficient work environment.

LabView Data Acquisition Programs Applied to Enhance Heat Transfer Experiments. *Maribel Valdez* (*Illinois Institute of Technology, Chicago, IL*)*; Jeff Collins* (*Argonne National Laboratory, Argonne, IL*). The Advanced Photon Source (APS) X-ray beam at Argonne National Laboratory provides luminous X-rays for diverse scientific experiments. The surface used to stop the beam is made of Glidcop (Aluminum oxide strengthened copper) and it is limited to 300°C and 450 MPa. Currently, the APS wants to increase the intensity of the beam thus two enhanced heat transfer experiments were employed to promote longevity of the beam strike surface. The first experiment tests a method currently implemented in the facility which uses round water-cooling passages containing wire coil inserts. These cooling passages are located above and beneath the beam strike surface and drastically improve convective heat transfer. The second experiment tests a future beam strike surface material, pyrolytic graphite, which has anisotropic properties that will reduce stresses provoked by thermal gradients. To ensure experimental reproducibility and provide an improved user-friendly interface, data acquisition and reduction programs have been implemented using LabVIEW software. This software easily acquires experimental data, reduces the raw data, and calculates non-dimensional coefficients (Prandtl's number Reynolds number, Biot number, Nusselt number and friction factors) needed to produce generalized correlations of the heat transfer process thereby enhancing data representation. Data reduction software provides a module to process and repeat high temperature heat transfer experiments. It will subsequently introduce new experiments to improve the cooling process. The APS beam strike surface is limited by thermo-mechanical design criteria. However, by promoting enhanced heat transfer experiments, safe operation and longevity of the X-ray beam life are promoted.

Development of EnergyPlus Utility to Batch Simulate Building Energy Performance on a National Scale. *Jayson Valencia* (*University of Washington, Seattle, WA*)*; James Dirks* (*Pacific Northwest National Laboratory, Richland, WA*). EnergyPlus is a simulation program that requires a large number of details to fully define and model a building. Hundreds or even thousands of lines in a text file are needed to run the EnergyPlus simulation depending on the size of the building. To manually create these files is a time consuming process that would not be practical when trying to create input files for thousands of buildings needed to simulate national building energy performance. To streamline the process needed to create the input files for EnergyPlus, two methods were created to work in conjunction with the National Renewable Energy Laboratory (NREL) Preprocessor; this reduced the hundreds of inputs needed to define a building in EnergyPlus to a small set of high-level parameters. The first method uses Java routines to perform all of the preprocessing on a Windows machine while the second method carries out all of the preprocessing on the Linux cluster by using an in-house built utility called Generalized Parametrics (GPARM). A comma delimited (CSV) input file is created to define the high-level parameters for any number of buildings. Each method then takes this CSV file and uses the data entered for each parameter to populate an extensible markup language (XML) file used by the NREL Preprocessor to automatically prepare EnergyPlus input data files (idf) using automatic building routines and macro templates. Using a Linux utility called "make", the idf files can then be automatically run through the Linux cluster and the desired data from each building can be aggregated into one table to be analyzed. Creating a large number of EnergyPlus input files results in the ability to batch simulate building energy performance and scale the result to national energy consumption estimates.

Spatiotemporal Variability in Soil Radon Fluxes to the Atmosphere. *Courtney Ward* (*California State University – Chico, Chico, CA*)*; Marc Fischer* (*Lawrence Berkeley National Laboratory, Berkley, CA*). Because of its ubiquitous release on land, radon is often used as a natural tracer of air transport. This study focuses on the use of radon to infer regional-scale fluxes of CO_2 and specifically characterization of the variability in the flux of radon from a wide range of soils. Currently, it is erroneously assumed that radon is independent of space and time, with a uniform flux rate of 1 atom cm^{-2} s^{-1}. A more detailed source term is highly desirable to improve validation of atmospheric transport models since the quality of validation is directly proportional to the quality of the radon source term used. To explore the variability in surface radon flux, measurements were conducted using a closed loop flux chamber and radon specific detector system. Measured radon fluxes ranged from 0.159 to 3.89 atoms cm^{-2} s^{-1}. Soil radon flux was also modeled both analytically and with a transient, finite-element model (Rn3D). Radon fluxes obtained from the numerical model under conditions of purely diffusive transport and a steady state radon flux obtained under conditions of a constant soil pressure gradient were compared to see the effects of different soil properties. Soil properties had strong impacts on both diffusive and advective flux in the model simulations. Simulated soil radon fluxes ranged from 0.106 to 4.46 atoms cm^{-2} s^{-1} depending on the soil moisture, permeability, porosity, radium content, and pressure gradient. Simulated flux rates support the hypothesis of large variability in soil radon fluxes to the atmosphere. These results suggest that in order to accurately estimate regional-scale fluxes of CO_2 one must consider the impacts of soil parameters and incorporate those into the estimated flux rates.

Conversion of Geothermal Silica into Value-Added Nano-Sized Materials. *Zhan Hang Yang* (*State University of New York at Stony Brook, Stony Brook, NY*)*; Devinder Mahajan* (*Brookhaven National Laboratory, Upton, NY*). Geothermal brines store natural heat that can be harnessed to produce thermal and electrical power. Unlike fossil fuels, it is a promising, sustainable natural resource with negligible CO_2, SO_2 and NO_x emissions. The circulating hot fluids below the Earth's surface dissolve minerals and metals like silica, lithium, zinc and manganese from the rocks they travel through. The presence of silica (SiO_2) and other chemicals is a major concern during power production from geothermal brines because it causes scaling and corrosion. The recovery of silica is highly desirable to reduce scaling and to offset the cost of power production. This research project is undertaken to investigate the conversion of silica of high purity into nano-sized, value-added materials such as silicon carbide (SiC) and silicon nitride. Sonication or ultrasound irradiation is employed since this technique is known to produce nanoparticles *in-situ*. The method involves cavitations, and within the cavities high pressures and high temperatures are generated that can be harnessed to drive chemical reactions. A carbonaceous source, dextrose or graphite, was sonicated with silica to yield silicon carbide. The product was characterized by X-ray diffraction (XRD) and Fourier Transform Infrared Spectroscopy (FTIR). The XRD patterns of collected solids suggested the presence of three different polytypes of silicon carbide, along with unreacted starting materials. The FTIR measurements showed the appearances of two new peaks at 1,015 and 815 cm- that are probably due to v(Si-O-C) and v(Si-C) stretching, respectively. The vibrations are tentative evidence of silicon carbide formation and possible indicator of the extent of reaction.

LabView Data Acquisition Programs Applied to Enhance Heat Transfer Experiments. *Priscilla Zellarchaffers* (*Illinois Institute of Technology, Chicago, IL*)*; Bharat* (*Argonne National Laboratory, Argonne, IL*). The Advanced Photon Source (APS) X-ray beam at Argonne National Laboratory provides luminous X-rays for diverse scientific experiments. The surface used to stop the beam is made of Glidcop (Aluminum oxide strengthened copper) and it is limited to 300°C and 450 MPa. Currently, the APS wants to increase the intensity of the beam thus two enhanced heat transfer experiments were employed to promote longevity of the beam strike surface. The first experiment tests a method currently implemented in the facility which uses round water-cooling passages containing wire coil inserts. These cooling passages are located above and beneath the beam strike surface and drastically improve convective heat transfer. The second experiment tests a future beam strike surface material, pyrolytic graphite, which has anisotropic properties that will reduce stresses provoked by thermal gradients. To ensure experimental reproducibility and provide an improved user-friendly interface, data acquisition and reduction programs have been implemented using LabVIEW software. This software easily acquires experimental data, reduces the raw

data, and calculates non-dimensional coefficients (Prandtl's number Reynolds number, Biot number, Nusselt number and friction factors) needed to produce generalized correlations of the heat transfer process thereby enhancing data representation. Data reduction software provides a module to process and repeat high temperature heat transfer experiments. It will subsequently introduce new experiments to improve the cooling process. The APS beam strike surface is limited by thermo-mechanical design criteria. However, by promoting enhanced heat transfer experiments, safe operation and longevity of the X-ray beam life are promoted.

Environmental Science

An Enclosure Study to Investigate the Causes of the decline of Southern Leopard Frogs (*Rana sphenocephala*) on Long Island. *Duncan Adams* (*Earlham College, Richmond, IN*); *Jeremy Feinberg* (*Brookhaven National Laboratory, Upton, NY*). Around the world amphibian species are declining at unprecedented rates due to a variety of causes. Some, such as habitat loss, are readily observable, while some amphibian declines are not as well understood. The southern leopard frog (*Rana sphenocephala*) is an anuran native to much of the eastern United States, including Long Island, New York. Formerly one of the most visible and abundant frog species on Long Island, it has declined over the last 30 to 50 years to the point that there has not been a confirmed sighting since 1998. This possible extirpation could be due to habitat loss, environmental contamination, disease, invasive vegetation, interspecific competition, or any combination of these factors. In order to test these hypotheses leopard frog tadpoles were used as bio indicators. Leopard frog eggs were collected from southern New Jersey and placed in screen enclosures located in Long Island wetlands. Measurements of the tadpoles will be collected weekly and dead tadpoles tested for disease and toxicity. Tadpole growth and survival rates for the different conditions will indicate the relative importance of competition, disease, and plant community to the leopard frog. In following years similar experiments will be done to test the same and other factors in southern leopard frog decline on Long Island. The use of leopard frog tadpoles as bio-indicators this year and subsequent findings will help to identify possible sites of relic populations, as well as allowing the design of more effective conservation efforts for southern leopard frogs and similar species.

Characterization of the Sunset Semi-Continuous Carbon Aerosol Analyzer. *Jace Bauer* (*Purdue University, West Lafayette, IN*) *Xiao-Ying Yu* (*Pacific Northwest National Laboratory, Richland, WA*). Atmospheric carbonaceous aerosols play a key role in climate forcing and global change. *In-situ* quantification of carbonaceous aerosols is therefore essential to reduce uncertainty in climate change models as well as for long-term monitoring by government agencies. The field deployable Sunset Semi-Continuous Organic Carbon/Elemental Carbon Aerosol Analyzer (Sunset OCEC) utilizes a modified National Institute for Occupational Safety and Health (NIOSH) thermal-optical method to determine total carbon (TC), organic carbon (OC), and elemental carbon (EC). It can provide *in-situ* semi-continuous measurements on an hourly basis; however, its performance is not yet fully characterized. Two collocated Sunset OCECs, identified as 'Unit A' and 'Unit B,' were used to characterize the relative standard deviation (RSD) and limit of detection (LOD) between June 23 and July 9, 2007 in Richland, WA. A high efficiency particulate air (HEPA) filter was utilized to determine the LODs of both instruments. The RSDs between the two Sunset OCECs are 9.1% for TC, 13.0% for optical OC, and 9.0% for thermal OC, indicating good precision between the instruments. In addition, the RSD for thermal EC is 29.0%, while optical EC is 48.3%. The LOD for Unit A is approximately 0.21 µgC/m3 for TC, optical OC, and thermal OC and ~0.004 µgC/m^3 for optical and thermal EC. Similarly, Unit B has an LOD of ~0.29 µgC/m^3 for TC, optical OC, and thermal OC, 0.018 µgC/m^3 for optical EC, and 0.004 µgC/m^3 for thermal EC. Several factors may have contributed to the poor RSDs of thermal and optical EC. First, the low EC mass loading at this location caused uncertainty in the measurements. Second, Unit B EC measurements were affected by a leakage in the oxygen valve. Third, the non-dispersive infrared detector in Unit B displayed excessive "noise," resulting in scattered optical EC measurements, which consequently worsened the comparison between Unit A and Unit B. Improved RSDs of all OC and EC parameters are expected after Unit B is repaired. Future work should reevaluate the precision of the Sunset OCECs and investigate the difference in various thermal-optical protocols on OCEC quantification.

Impacts of Mercury Emissions from Coal-Fired Power Plants in Western Pennsylvania. *Michele Bender* (*Mount Saint Mary College, Newburgh, NY*); *Carlos Bu* (*Monroe Community College, Rochester, NY*); *John Heiser, Terry Sullivan* (*Brookhaven National Laboratory, Upton, NY*). Mercury, a neurotoxin, is toxic to humans, especially in the brain, nervous system, kidney, and liver. Power plants are the biggest source of mercury emissions in the United States. When fully implemented by the U.S. Environmental Protection Agency (EPA), the Clean Air Interstate Rule and the Clean Air Mercury Rule will lead to a reduction in mercury emissions from coal-fired power plants by 70% to 15 tons per year by 2018. The EPA estimates that due to these higher restrictions mercury deposition will be reduced 8% on average in the eastern United States. A concern exists that the deposition of mercury near power plants will be much greater than average, leading to a "hot spot" where exposure may be greater than desired. For this study, a "hot spot" is defined as an area no less than four square miles with a mercury concentration higher than the average by one standard deviation. The goal of this study is to determine the effect of three coal-fired power plants on the surrounding environment in western Pennsylvania. During the growing season, oak leaves collect deposited mercury from the power-plant emissions and have a large surface area to collect mercury. The study focused on oak leaves from leaf litter within a five-mile radius of each power plant. Sample collection began with mapping of the area around the power plants to determine easy access locations within circular sampling rings, and collection of oak leaves from the leaf litter at the sampling locations. The samples collected were dried, ground into small particles, and processed using a Direct Mercury Analyzer to calculate the mercury content in the samples. After the results were collected, the data was analyzed to determine if "hot spots" occurred. The results did not indicate a "hot spot" in the region near the power plant. However, the information shows a possible effect of the power plants increasing mercury concentration in a southeast direction, consistent with the prevailing wind pattern. The data shows a possible correlation of elevation increasing deposition, but the data is not conclusive. Therefore, the power plants had little impact on the presence of a "hot spot" on the surrounding area.

Post-Breeding Dispersal and Terrestrial Habitat Use by Woodhouse's Toad (*Bufo woodhousii*) on the Hanford Reach National Monument. *Shannon Blackburn* (*Western Washington University, Bellingham, WA*); *James Becker* (*Pacific Northwest National Laboratory, Richland, WA*). Anurans serve as key biological indicators of environmental health due to their use of both terrestrial and aquatic habitats and permeable skin. However, knowledge regarding terrestrial habitat use is relatively unknown. The purpose of this study was to evaluate the post-breeding dispersal, aestivation locations, and identify terrestrial habitat use of Woodhouse's toads (*Bufo woodhousii*) at the Hanford Reach National Monument. We used radio-telemetry to track the movements of thirty-two Woodhouse's toads from July 13th–August 20th, 2007 at two pools after cessation of most breeding activity. We found that during late-breeding season and summer aestivation, adult Woodhouse's toads utilize a variety of different environments; temporary and permanent pools, wetlands, and dry upland areas up to 1.12 km away from the breeding site. The observed mean distance, the sum of linear movements between locations, was 479 m and toad movement was not significantly correlated with snout-vent-length (R2=0.0588). The toads were observed burying in fine sand, silts, and clays in exposed areas, underneath vegetation litter, and in small animal burrows. Woodhouse's toads had significantly shorter movements at the pool with a dense community of tall grasses than at the pool with a drier, anthropogenic-modified habitat.

Study of Chloride Mass Balance Preparations. *Chase Bovaird* (*The George Washington University, Washington, DC*); *Jeff Serne* (*Pacific Northwest National Laboratory, Richland, WA*). Chloride Mass Balance (CMB) is an inexpensive and effective way to estimate groundwater recharge in arid or semi-arid environments. CMB analysis is important to the Hanford Site in its ongoing environmental cleanup efforts, in that estimation of contaminant flow is important to regulators. Past studies have resulted in data that show an increase in chloride concentration when 1:1 water extracts are prepared by oven drying or when the water is allowed a prolonged contact time with the sediment. Using 1:1 water extract method with air dried and oven dried sediments, chloride analyses were performed with an ion-chromatograph mass spectrometer (IC-MS). Analysis with IC-MS was also performed on 1:1 sediment-water extracts after contact times of 1, 3, and 7 days. Expected results, commensurate with assumptions made in CMB analysis should show neither chloride loss from porewater from oven drying sediment nor an increase. Further, there should be no increase